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EVALUATION OF HIGHWAY ADVISORY RADIO (HAR) IN A CONSTRUCTION ZONE ON I-80, MORRIS COUNTY, N.J.

By
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JUNE 1989

Prepared By
New Jersey Department of Transportation
Bureau of Transportation Technology Research

In Cooperation with
U.S. Department of Transportation
Federal Highway Administration

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16. Abstract

Between early May and mid-November, 1985 a highway advisory radio system (HAR) installed on a construction site on I-80 in Morris County, N.J. was evaluated for effectiveness and reliability. To test effectiveness traffic and driver interview data was collected for HAR ON and HAR OFF conditions. The interviews were obtained from drivers of passenger cars and other light vehicles just after they left the construction zone. Interviewers read a list of prepared questions and recorded the answers (yes or no). When tabulated, these answers yielded the percentages of drivers who had seen the warning signs, tuned in to HAR, understood the message, etc. Reliability was determined by keeping a log of type and frequency of malfunctions, and broadcast field strength readings at various locations in the broadcast area.

The results of the study showed that 1) Visibility of warning signs was greatly increased by highlighting the signs with arrowboards; 2) Although 78 % of the drivers saw the highlighted signs, only 40 % of them tried to tune in to HAR; 3) There is no indication that HAR was effective either as a traffic control or a safety device; 4) The particular equipment used was considered unreliable in that all major components failed at least once, and some as many as four times.

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SUMMARY AND CONCLUSIONS

In May, 1985 a Highway Advisory Radio (HAR) system was installed along I-80 westbound in Mt. Arlington Boro and Roxbury Township, New Jersey - about two miles east of Netcong (see Figure 1, page 9). The system was operated in conjunction with a construction project undertaken to rehabilitate the mainline and interchange bridges in the area, and was evaluated as an adjunct to the traffic control and safety devices normally used in a construction zone. It was also evaluated for reliability and cost-effectiveness. The system comprised four main components: a digital recorder to record messages and a telephone phone handset to record and listen to playback prior to broadcast; an antenna consisting of two 3/4-mile-long sections of coaxial cable buried in the median about one foot from the westbound lanes; two transmitters - one for the east leg and one for the west leg of the antenna. Ancillary items included a weatherproof metal housing for the electronics and cooling fans. Figure 2, page 12 is a block diagram of the system. A complete list of equipment, including specifications, is in Appendix I, page 44.

Advisory signs notifying motorists to tune in to HAR on 530 AM were placed one mile and one-half mile east of the antenna, and at the point where the broadcast began. (See Figures 3 and 4, pages 13 and 14.) Thus motorists had approximately 60 seconds to prepare for the broadcast, another 90 seconds to listen to the message (see Introduction , page 11), and another 3-4 seconds afterward to reduce speed and maneuver into the correct

lane. Traffic counts and speeds (from videotapes) and driver interviews were obtained between late May and mid-November. Drivers were read questions from a prepared questionnaire, which is shown in Figure 7, page 25. Both traffic and interview data were collected for four different HAR conditions:

1. HAR OFF - Under this condition all of the HAR warning signs were covered so that in theory, at least, the motorists were unaware of the existence of the system and did not have the added warning that the message gave them about the construction zone ahead.

2. HAR ON: ONE SET OF SIGNS (HAR ON 1) - This was the initial condition for the study, with the three warning signs placed on the right-side berm. Figures 3 and 4, pages 13 and 14 show the sign locations and the particular sign placed at each. An inspection of the questionnaires obtained after a few days of interviewing indicated that about half the motorists failed to see the HAR warning signs. This led to the changes described below.

3. HAR ON: TWO SETS OF SIGNS (HAR ON 2) - An identical set of signs was placed in the median, opposite those on the right-side berm. This increased the percentage of interviewees who saw the signs to about 68%.

4. HAR ON: TWO SETS OF SIGNS WITH ONE SET DELINEATED BY ARROWBOARDS (HAR ON 2L) - For this condition the signs in

the median were highlighted by arrowboards. This resulted in 78% of the motorists interviewed replying that they had seen the HAR signs.

The purpose of collecting both HAR ON and HAR OFF data was to provide a comparison between traffic populations for the four conditions. From the traffic counts and speeds we were able to determine the effect of the three HAR ON conditions versus HAR OFF. Table II, page 35 shows the results of driver interviews for all three HAR ON conditions, both for the number who could answer and for the total number of drivers interviewed. Clearly not all drivers could answer all questions. For example, a driver who did not see the HAR advisory signs could not be expected to tune in to HAR. This lack of independence between questions and answers obviously had to be considered in the analysis of the data and tabulation of the results.

Field strength readings were taken from May, 1985 into June, 1986 at various locations along both legs of the antenna.(See Figure 7, page 25.) These served three purposes: 1) To monitor system performance in general as the system was being subjected to a full range of weather conditions; 2) To assist in locating the source of problems during system malfunctions; and 3) To determine compliance with FCC regulations.

When the system was in good working order it was easy to use and broadcast a loud, clear message along the entire length of the antenna. However, the negative findings listed below far outweigh these positive factors and should be given prime consideration if future HAR installations are contemplated.

1. Concerning the effectiveness of HAR as a traffic control and safety device, Table II, page 35 clearly shows that each succeeding change in sign format resulted in a greatly increased percentage of drivers seeing the signs, and that for the highlighted signs (Item 4. above) at least, a much larger percentage tried to tune in to HAR. However, there is no indication from the traffic data that HAR had any effect since the speeds for both cars and trucks at both camera locations (see Figure 5, page 19) did not change appreciably for any of the three HAR ON conditions versus the HAR OFF condition or between the HAR ON conditions themselves. Furthermore, the percentage of vehicles passing Camera Location 2 with headlights on (for all HAR ON conditions) was less than 1%, which was far lower than the 20% - 40% of the drivers who claimed that they had tuned in to HAR.

2. Driver apathy toward HAR in this setting (which is described in RESULTS AND DISCUSSION, page 37) was emphasized by the fact that more than 60% of those who did see the highlighted signs made no effort to try to tune in to HAR. Although drivers were not questioned as to why they had made no effort to tune in after they had seen the signs, many nevertheless volunteered reasons. These are listed in RESULTS AND DISCUSSION, page 36.

3. Concerning the equipment itself, there are two major points to consider. The first is that the buried antenna was a constant problem since it was adversely affected by moisture in the ground. The basic problem was compounded by the fact that the soil in the area did not drain well overall and that drainage varied considerably at different locations along the antenna. This resulted in such large variations in signal strength and message clarity that there were often dead spots along the antenna or the message was unintelligible.

The second point is that neither the recorder, nor the transmitters, nor the cooling fans were reliable. During the six-month period that traffic and interview data were collected, all of these items failed from 1 to 4 times. These failures were sometimes compounded by the slow response of the contractor in affecting repairs, so that data collection was repeatedly delayed and eventually took about twice as long as originally planned.

The various problems with the equipment and the delays which occurred in affecting repairs are cited Appendix II, page 68 which contains copies of two memoranda sent to the Resident Engineer who was overseeing the construction contract of which HAR installation and maintenance was a part.

RECOMMENDATIONS

These recommendations are based directly on the data obtained from traffic videotapes, interview sheets, field strength readings, and the log of the various malfunctions and repairs.

1. The only successful signing arrangement was that which used arrowboards to highlight the signs in the median. We therefore recommend that highlighting be used not only for HAR installations, but for any installation requiring special signs used to impart "unusual" information to drivers.

2. We strongly recommend against using the Radio Systems TR-20 TIS transmitters and the RA-9 antenna cable, and the Cook 21330 recorder. All of these items proved to be unreliable (See Appendix II, page 68). While the cooling fans were also unreliable, this may have been a result of the wrong fans being installed. We discovered after the system had been in place for over three months that the fans were apparently not rated to function at the high temperature which developed in the equipment housing during hot weather. It is not known whether or not the fans would have worked correctly had ones rated for a higher working temperature been installed.

3. We recommend against using a buried cable as an antenna for several reasons. Installation of such an antenna is relatively difficult and expensive; care must be taken in backfilling the trench so that the cable is not damaged by rock or debris; the water table and drainage must be considered to minmize the effects of moisture on the message strength and clarity; the antenna must be kept clear of metal objects such as bridge railings and guide rails, which will produce dead spots in the output; last, this type of antenna is permanently fixed, which could be a considerable disadvantage on some types of construction projects.

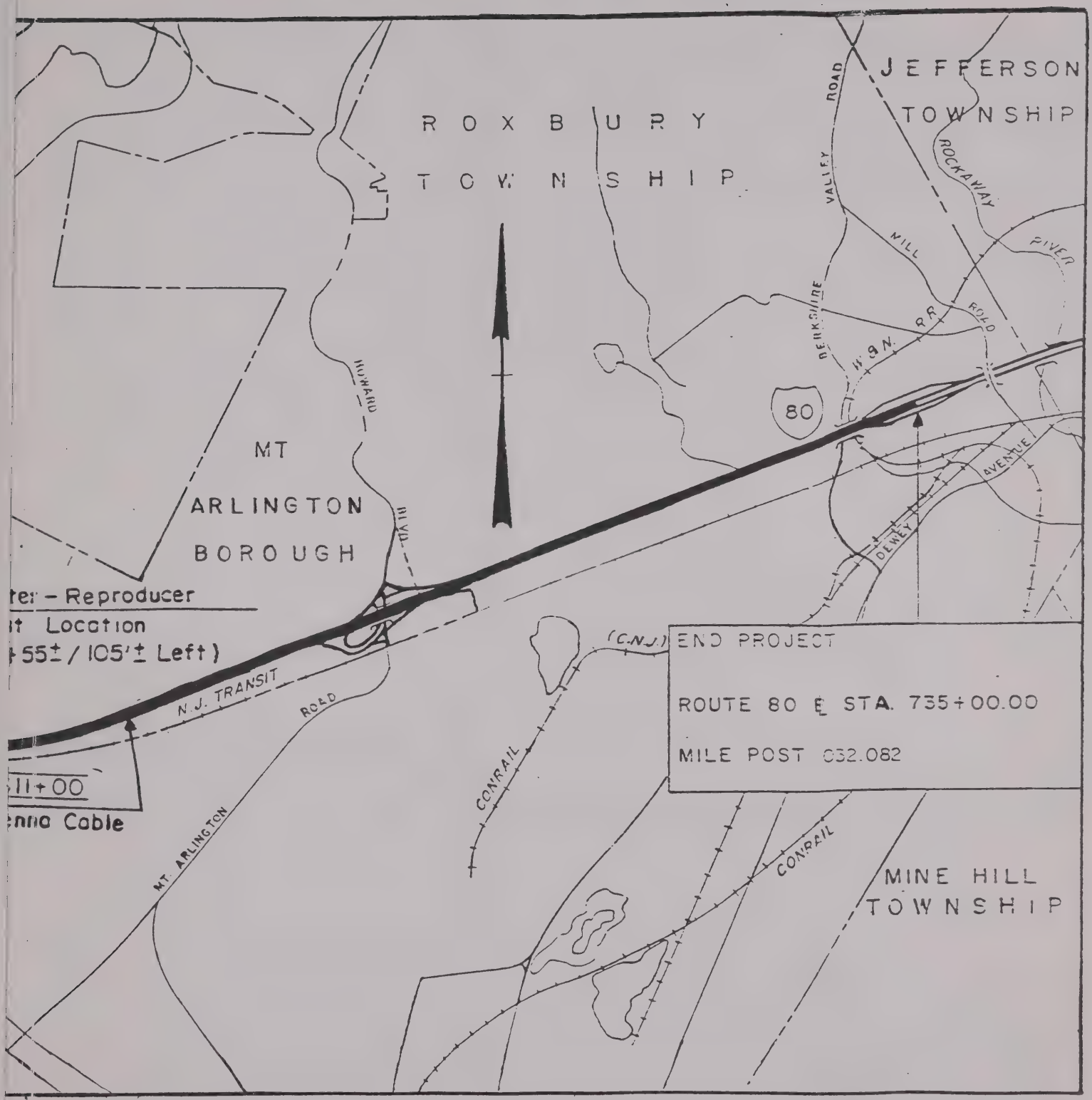
4. We cannot recommend HAR as being cost-effective for the setting in which it was tested. (See RESULTS AND DISCUSSION, page 41) The cost of the equipment and installation combined was $85,000, which was included as a single item in the construction contract. We found from the traffic data that the message had virtually no effect on traffic speeds, and from the interview data that more than half of the drivers who saw the HAR warning signs ignored them. While there were accidents in the construction zone that could be attributed to the construction as the cause, they were not related to HAR OFF. Therefore we must assume that HAR ON did not contribute to either traffic safety or traffic control, and that at $85,000 it was certainly not cost-effective.

INTRODUCTION

Highway Advisory Radio is a highly-localized AM radio broadcast operated under FCC license and designed to inform drivers of specific highway conditions or commercial activities. The broadcast is received through a normal AM automobile radio, tuned to either 530KH or 1610KH, these frequencies being designated for HAR broadcasts by the FCC. In addition to assigning one of these frequencies to the licensee, the FCC requires that the power be limited to 50 watts and the field strength of the signal to a maximum of 2 millivolts at 60 meters from the antenna, for cable antennas.

The commercial use of HAR has been very effective, notably at Disney World in Orlando, Fla., Great Adventure in Jackson Township, N. J., and Hershey Park in Hershey, Pa. The success of these installations is primarily due to the fact that people visiting the facilities are doing so by choice, and want as much information as possible about what is being offered and how to avail themselves of the various entertainments. In contrast, HAR used as a traffic control or assistance device whether or not in conjunction with highway construction has been generally ineffective,[1] one notable exception being the use of HAR as part of the I-35W Traffic Management System by the Minnesota DOT.[2] The HAR system in this study was installed on I-80 in Roxbury Township and Mt. Arlington Boro (see Figure 1, page 9) as part of a construction contract for the rehabilitation of

(1) References (4), (5), and (6)
(2) Reference (3)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INTRODUCTION

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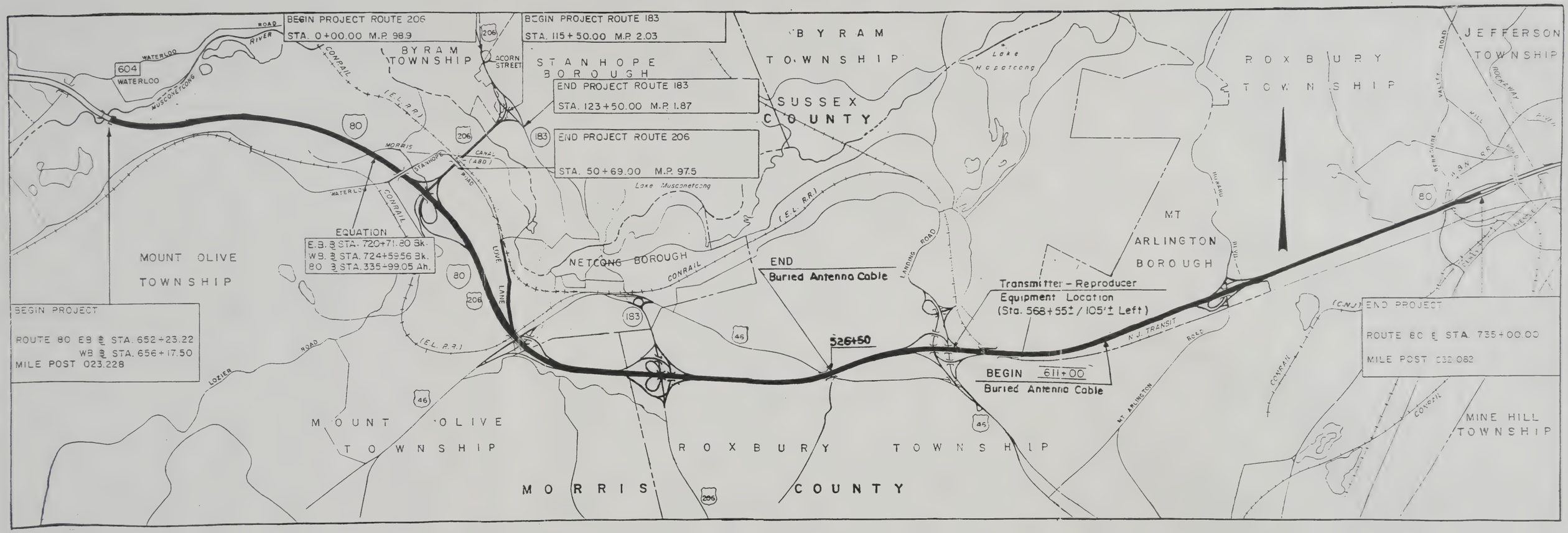
(2) Reference (3)

FIGURE 1

MAP OF CONSTRUCTION AREA SHOWING HAR LOCATION



bridges on the mainline and in the interchanges along a nine-mile section of the highway. I-80 is the major east-west highway in northern New Jersey, connecting at the east end with I-95 and the New Jersey Turnpike a few miles from the George Washington Bridge, and at the west end with I-80 in Pennsylvania at the Delaware Water Gap. It is heavily traveled by commercial, commuter, vacation, and local traffic throughout most of its length, so it was assumed that there would be congestion because of the construction and that this would make a suitable location for testing the effectiveness of the HAR system. The final cost of the system, exclusive of research costs, was $85,000. It was installed by Radio Systems of Edgemont, Pa., a subcontractor to Lightning Electric of Millburn, N. J. who were the electrical contractors for the entire construction contract. It consisted of four major units: a Cook 21330 solid state recorder and announcer, equipped with a telephone handset to record and listen to messages on playback before broadcasting them; two Radio Systems TR-20 TIS solid state transmitters (one for each leg of the antenna) set to broadcast on 530KH; an antenna consisting of two 3/4-mile sections of Radio Systems RA-9 coaxial cable, buried about 12 inches below the surface of the median, about two feet from the edge of the westbound inside lane. The transmitters, recorder, and two Hoffman A-PA4AXFN cooling fans were housed in a Hoffman A-42H30BLP metal cabinet supported on steel pipes set in concrete. Figure 2, page 12 is a block diagram of the equipment setup. Power for the electronics was 120 VAC, taken from a nearby Jersey Central

Power and Light pole. The recorder had a battery back-up so that the message would not be lost in the event of a power failure. Detailed descriptions and specifications for all components can be found in Appendix I, page 44.

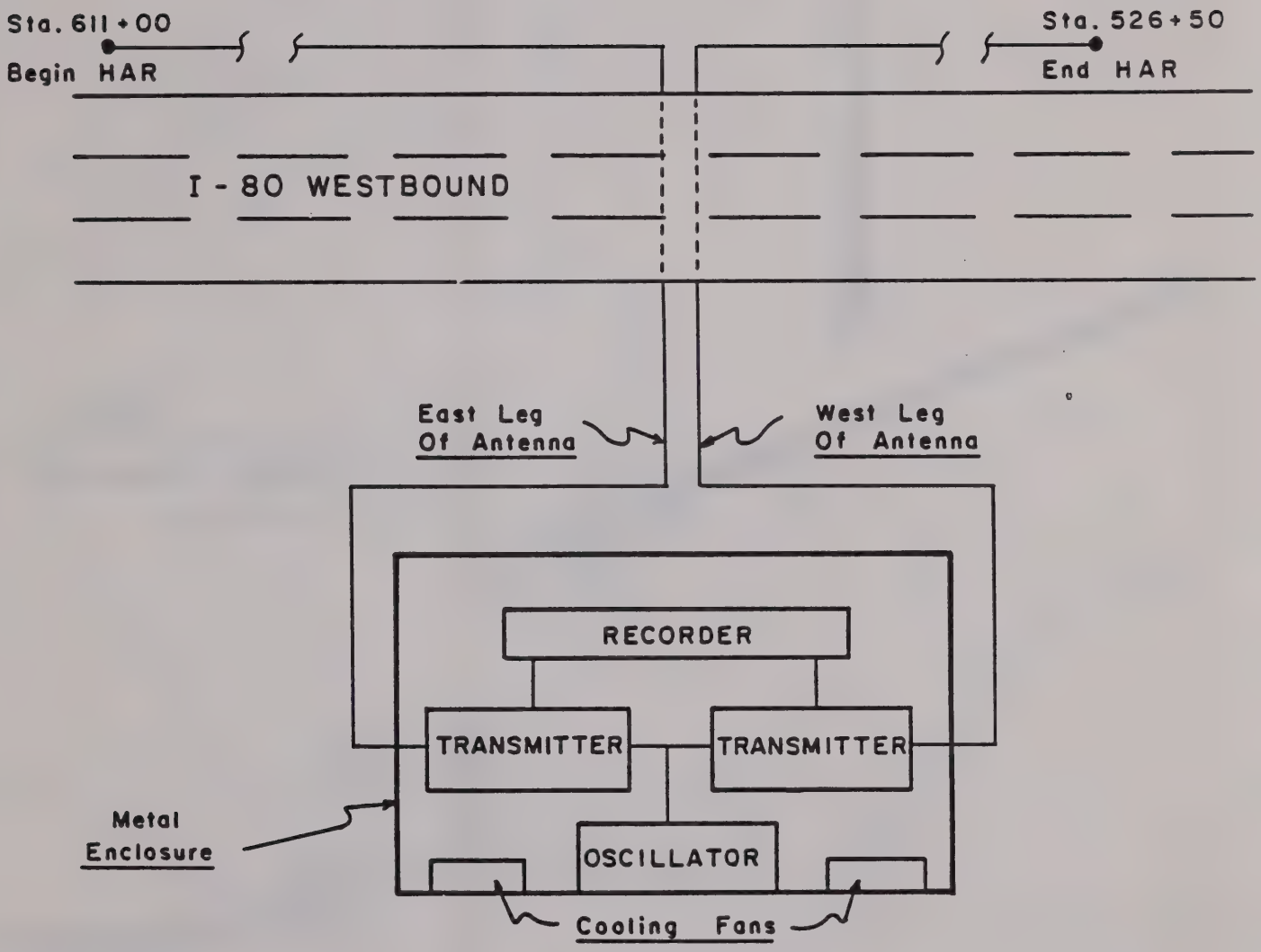
All of this equipment was located at the mid-point of the antenna so that one leg ran 3/4-mile to the east and the other ran 3/4-mile west, along the westbound lanes only, each end being terminated by a copper grounding rod. The west end of the antenna was about three hundred feet from the demarcation of the beginning of the construction zone, so that drivers were exposed to the 20-second message for at least four cycles and then had another 3-4 seconds to react to the reduced speed and lanes signs before actually entering the construction zone. See Figures 1 and 3, pages 9 and 13 for details of the transmitter and antenna location.

Warning signs which advised drivers to tune in to HAR on 530 AM were placed one mile and one-half mile east of the eastern terminus (the beginning) of the antenna. A third sign which stated that the HAR started broadcast at that point was placed at the east end itself. Sign location is shown in Figure 3, page 13, and their dimensions, lettering, etc. are detailed in Figure 4, page 14.

The system was first put into operation on May 9, 1985 at which time the research personnel involved familiarized themselves with the system in general and the message recording and erasing steps in particular. As a test of the reliability, it was decided to record and broadcast a nonsense test message

Figure 2

BLOCK DIAGRAM OF HAR COMPONENTS



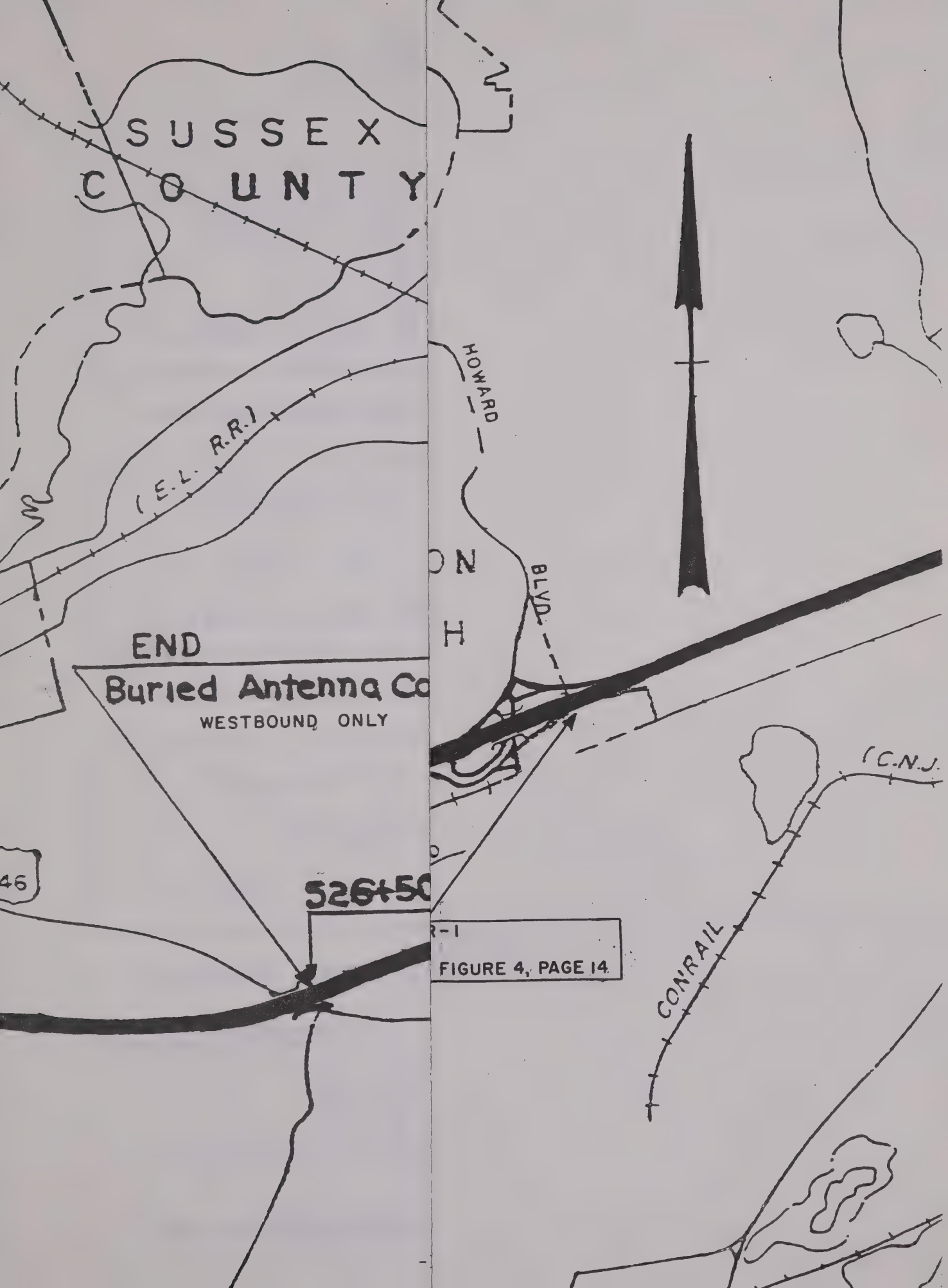

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FIGURE 4, PAGE 14

FIGURE 3

HAR WARNING SIGN LOCATIONS

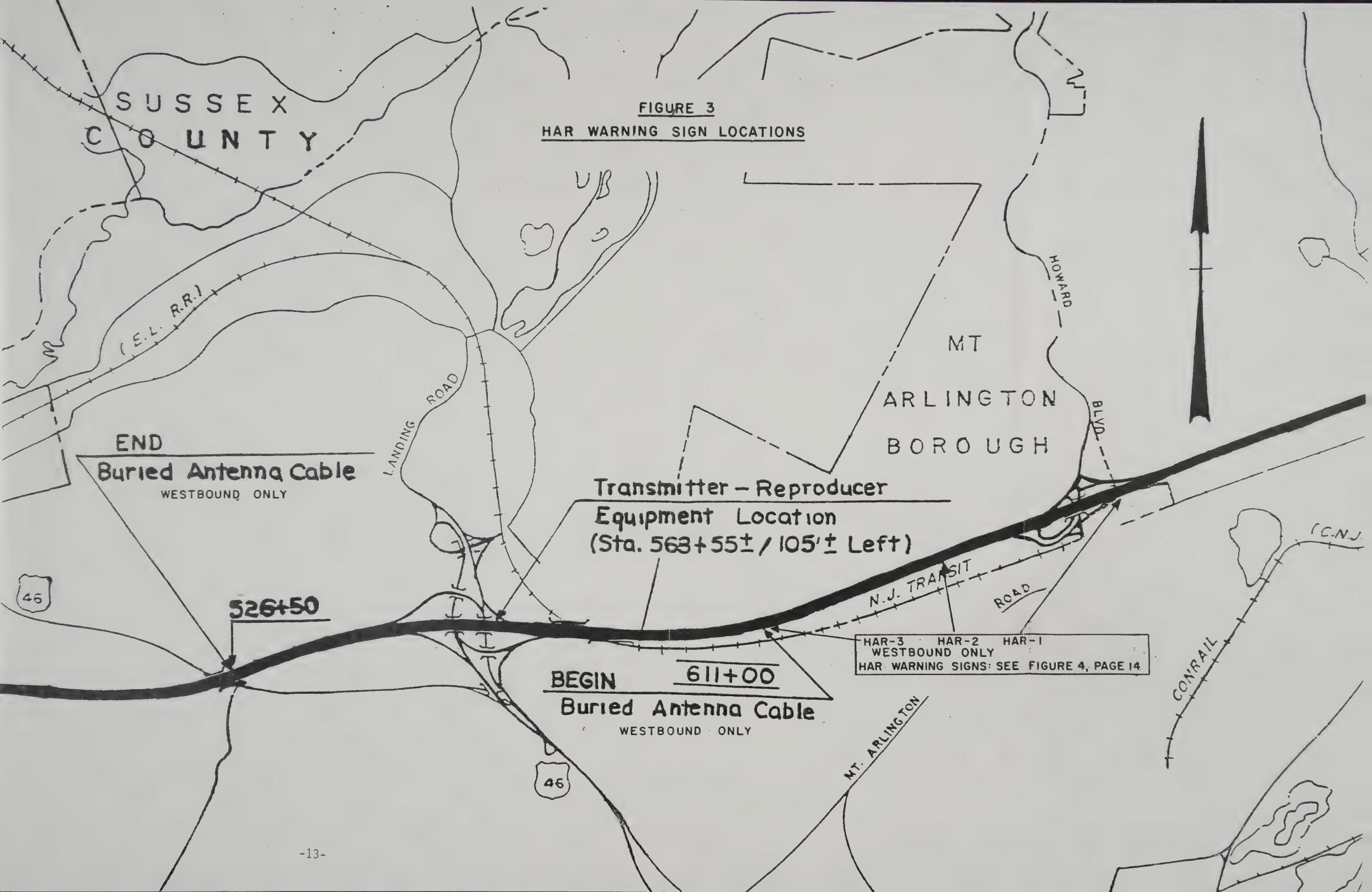
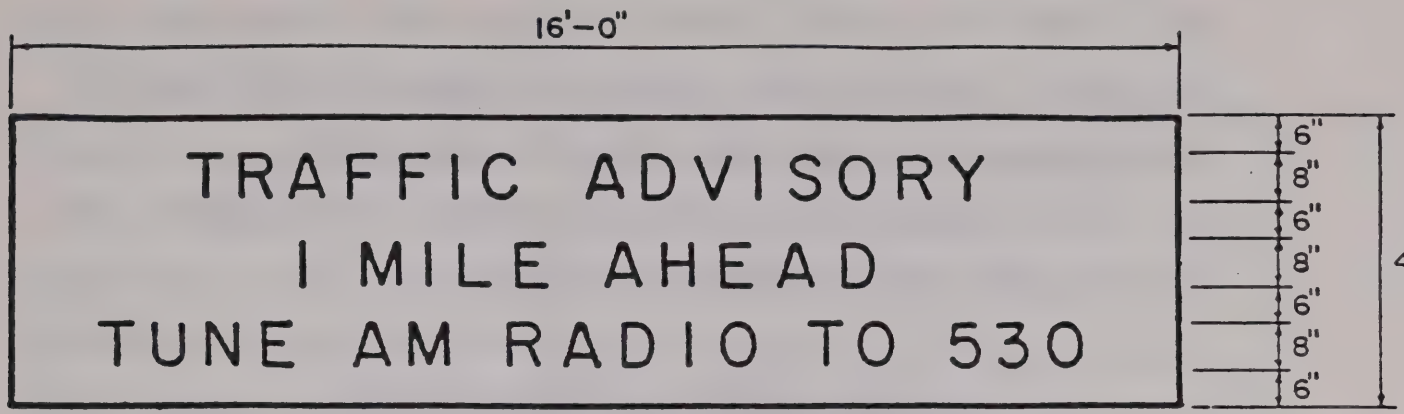
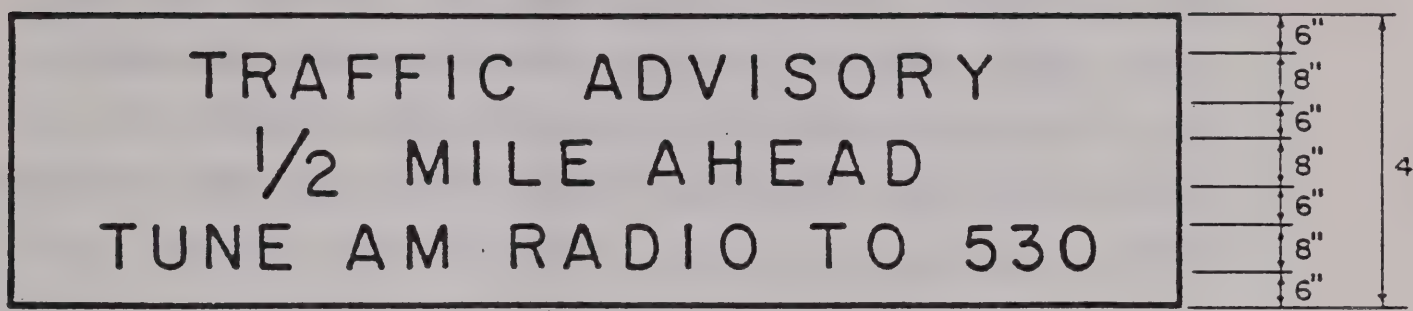


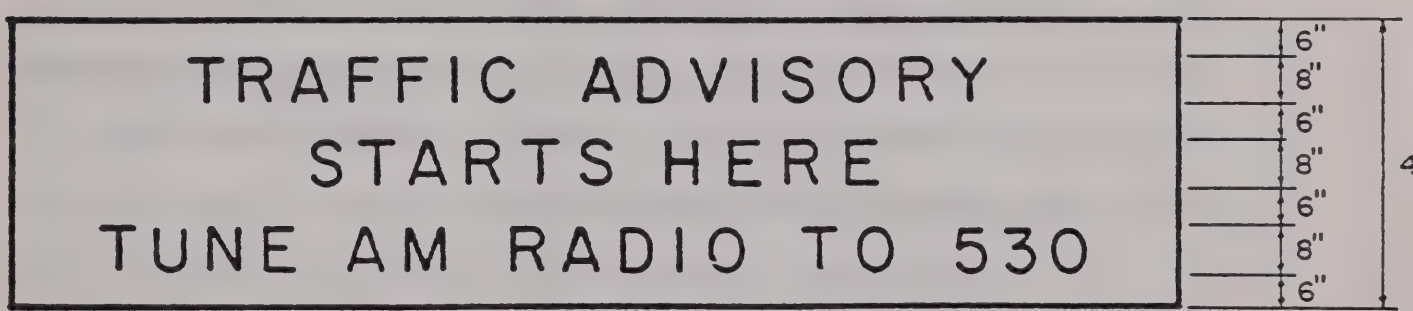
FIGURE 4
HAR WARNING SIGNS



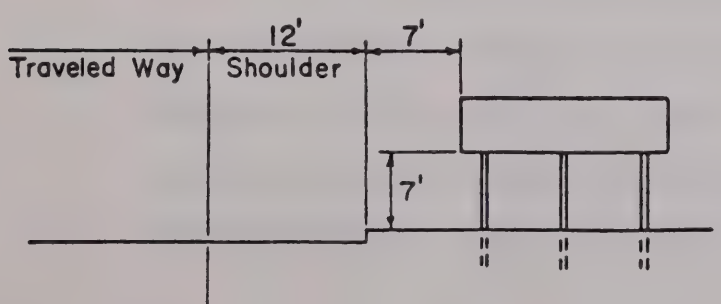
TEMPORARY GUIDE SIGN, TYPE GA, HARS-1



TEMPORARY GUIDE SIGN, TYPE GA, HARS-2



TEMPORARY GUIDE SIGN, TYPE GA, HARS-3



SIGN LOCATION DETAIL

ALL SIGNS: ORANGE BACKGROUND WITH BLACK LETTERING.

at all times when the warning signs were covered. This message also acted to prevent those motorists who already knew about the system from previous trips or newspaper articles from disregarding the signs when they were uncovered.

The standard traffic advisory message, shown below, was used only when the signs were uncovered.

STANDARD TRAFFIC ADVISORY MESSAGE

THIS IS TRAFFIC ADVISORY RADIO. THERE IS A CONSTRUCTION ZONE AHEAD. PLEASE TURN ON YOUR HEADLIGHTS FOR SAFETY. THE SPEED LIMIT WILL BE 40 MILES PER HOUR AND THE LEFT LANE WILL BE CLOSED. PLEASE MAINTAIN TWO LANES OF TRAFFIC AND OBEY ALL POSTED SIGNS.

Field strength readings were taken at various points along the antenna starting in mid-May, 1985, and at irregular intervals thereafter until June 10, 1986 so that the equipment would be subjected to the full range of weather conditions during the course of data collection.

DATA COLLECTION

Three general types of data were to be collected. These were traffic counts and speeds, to be obtained from videotapes; driver response to the HAR system, to be obtained from on-site interviews using prepared questionnaires; radio system performance data, to be obtained from periodic field strength readings and general inspections of the equipment and antenna area. The entire construction area was examined in April and early May, 1985 for potential data collection sites, which were subsequently selected. Videotaping of traffic was begun during the very early stages of construction, at which time the traffic restrictions were not in effect and HAR was not being utilized. These tapes provided us with traffic counts and speeds which were later compared to those obtained during construction for the HAR ON and HAR OFF conditions. The first set of field strength readings were also taken during this period in order to determine compliance with FCC regulations.

Traffic Data - Traffic data collection took place between May 31 and November 14, 1985 for four specific conditions.

1. HAR OFF - All of the HAR warning signs were covered so that motorists were unaware of the existence of the system. For the most part this seemed to work, even though some of the traffic was local or commuter traffic and undoubtedly some of these drivers must have seen the

Signs at some time during the six-month period when HAR was on. Also, at least two newspapers carried articles about the system despite our requests that these articles be witheld until after data collection had been completed. During the HAR OFF condition a nonsense message was broadcast so that drivers who already knew about the system would not react to it. The message also served as a test of the reliability of the system since it kept it in continuous use, including weekends.

2. HAR ON: ONE SET OF SIGNS - (HAR ON 1) For the initial part of the study, one set of three warning signs was placed on the right-side berm. An inspection of the questionnaires after the first few days of interviewing indicated that about half the motorists failed to see the warning signs. This led to the changes described below.

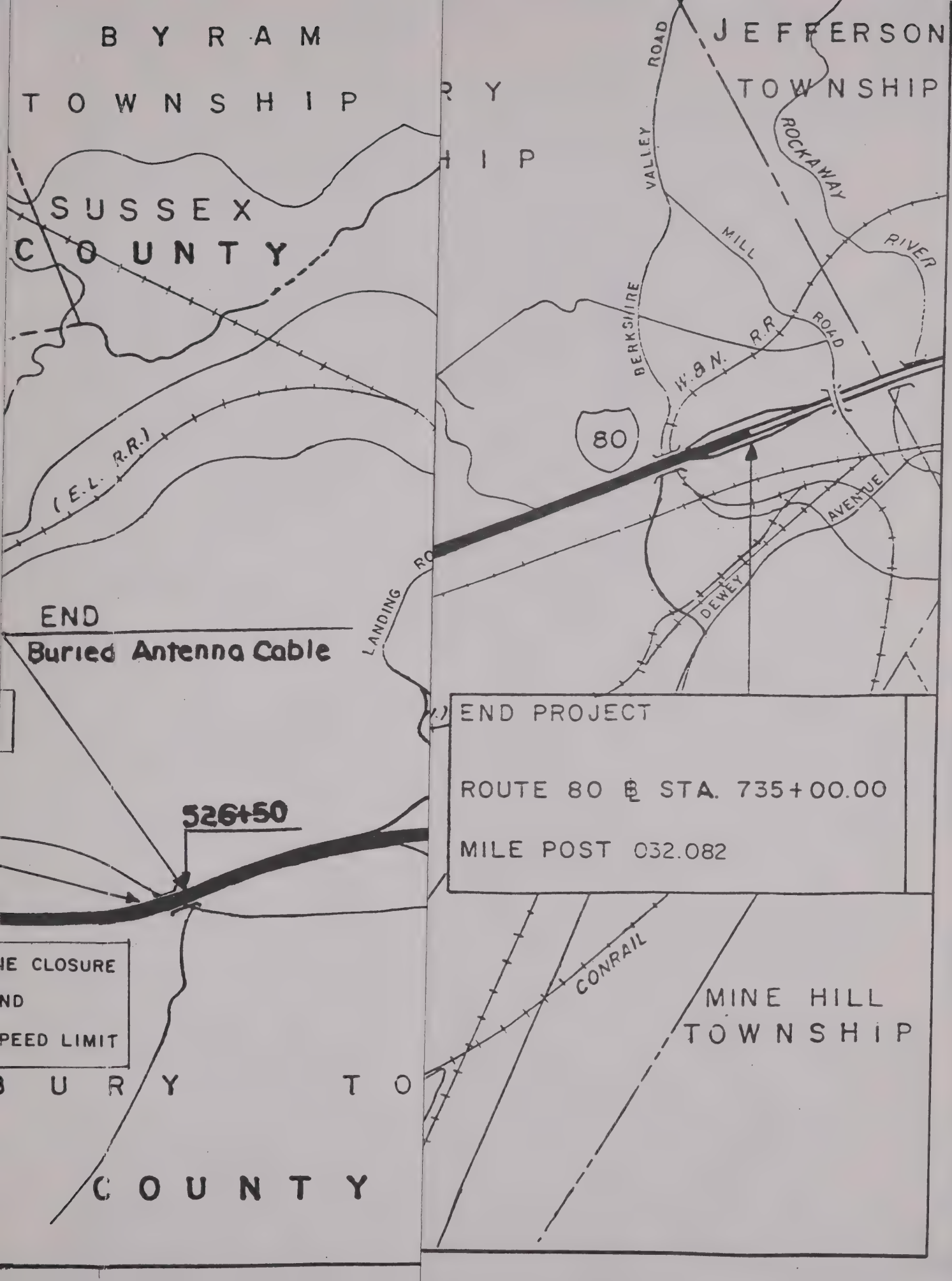
3. HAR ON: TWO SETS OF SIGNS - (HAR ON 2) A second set of signs, identical to the first, was placed in the median opposite those already in place. This increased the percentage of interviewees who saw the signs to about 68%.

4. HAR ON: TWO SETS OF SIGNS WITH ONE SET DELINEATED BY ARROWBOARDS - (HAR ON 2L) For this condition the signs in the median were highlighted by arrowboards. This resulted in 78% of the motorists interviewed replying that they had seen the signs.

Traffic data videotaping was at two sites, both of which were sufficiently elevated so that the camera had a clear view of all lanes and traffic. Camera Location 1 was at the transmitter (the antenna midpoint) at which point all westbound traffic passing the camera had already passed the HAR warning signs and had been exposed to two cycles of the 20-second message, if the driver had tuned in for any of the HAR ON conditions. Camera Location 2 was about 2500 feet west of the west end of the antenna. At this point all westbound traffic had been restricted to two lanes (instead of three) and the speed limit reduced from 55 mph to 40 mph, starting at about 300 feet from the west end of the antenna. Figure 5, page 19 shows the location of the video cameras.

At both camera locations we placed marks on each side of the westbound roadway, at measured distances from each other and in clear view of the video cameras. These marks were used in the lab to detemine speed by lanes and vehicle type, for each location. Vehicle counts were also by lane and type, for one-hour increments. The date and time were superimposed on all videotapes.The clock ran continuously, showing the hour, minute, second, and one-hundredth of a second. Hourly volumes and average speeds by lane and vehicle type are shown in Appendix III, pages 77-85 for both camera locations.

Interview Data - The interview site was originally set up at about Station 395 westbound, about 200 feet west of the restricted two-lane construction area. (See Figure 5, page 19.)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TOWNSHIP
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ROCKAWAY
MILL
RIVER
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CONRAIL
MINE HILL
TOWNSHIP
COUNTY

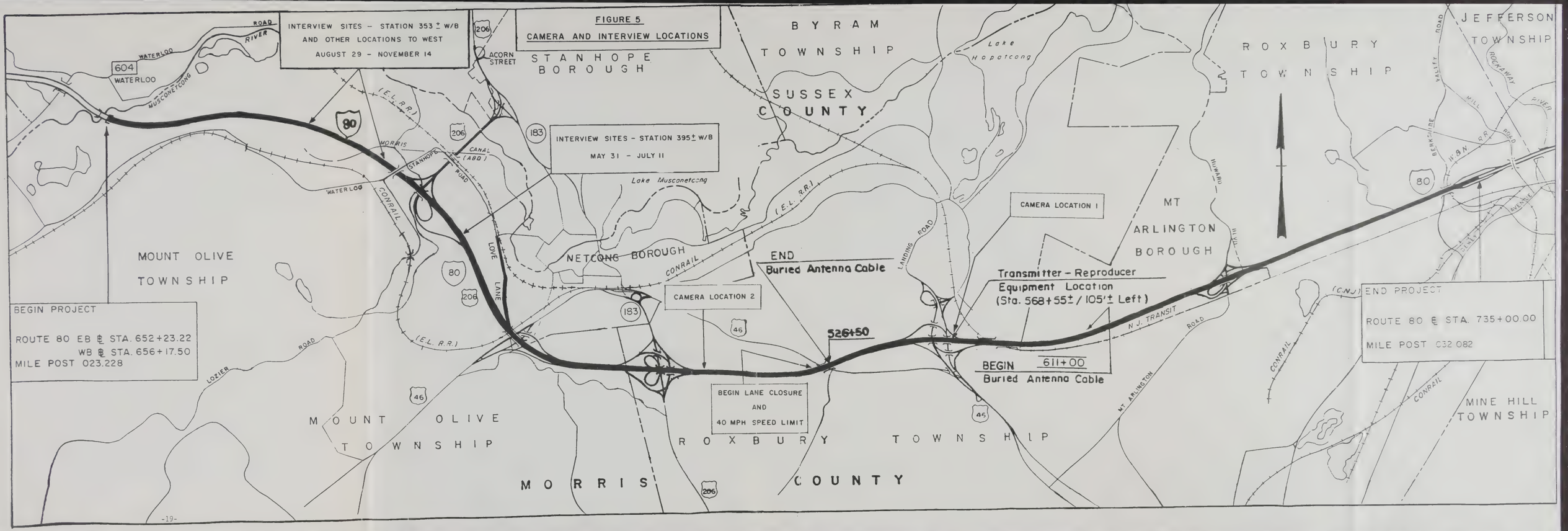


FIGURE 5
CAMERA AND INTERVIEW LOCATIONS
INTERVIEW SITES – STATION 353± W/B AND OTHER LOCATIONS TO WEST
AUGUST 29 – NOVEMBER 14
INTERVIEW SITES – STATION 395± W/B
MAY 31 – JULY 11
BEGIN PROJECT
ROUTE 80 EB ℄ STA. 652+23.22
WB ℄ STA. 656+17.50
MILE POST 023.228
END PROJECT
ROUTE 80 ℄ STA. 735+00.00
MILE POST 032.082
CAMERA LOCATION 1
CAMERA LOCATION 2
END
Buried Antenna Cable
526+50
Transmitter – Reproducer
Equipment Location
(Sta. 568+55± / 105'± Left)
BEGIN 611+00
Buried Antenna Cable
BEGIN LANE CLOSURE
AND
40 MPH SPEED LIMIT
MOUNT OLIVE TOWNSHIP
NETCONG BOROUGH
STANHOPE BOROUGH
BYRAM TOWNSHIP
SUSSEX COUNTY
MT ARLINGTON BOROUGH
ROXBURY TOWNSHIP
MORRIS COUNTY
JEFFERSON TOWNSHIP
MINE HILL TOWNSHIP
WATERLOO
Lake Musconetcong
Lake Hopatcong
(E.L. R.R.)
CONRAIL
N.J. TRANSIT
(CNJ)
80
46
206
183
604

It was assumed that traffic at that point would not yet have regained normal highway speed nor spread out to three lanes after leaving the two-lane construction area, thus making it simpler and safer to direct vehicles into the coned-off section of the shoulder where the interviews were conducted. The selection of vehicles and their direction into the interview area was done by a state trooper who assisted the field crew during the actual interview periods, which were from approximately 11 AM and 3 PM. Only passenger cars and other light vehicles were selected for interviewing. Details of the interviewing procedure are in Appendix IV, page 86. The interview questionnaire is shown in Figure 6, page 21.

The construction project included resurfacing several thousand feet of I -80 west of Camera Location 2. As a result of this repaving operation we were forced to move the interview site west to approximately Station 353 westbound on August 29 and about another 1/2 - mile west on September 5. The approximate locations of the various sites are shown in Figure 5, page 19. From August 29 through November 14 we were not able to use our original interview site which made the results of Q.4 (HEADLIGHTS ON?) somewhat questionable since by the time they had reached either of the later interview sites some of the drivers who had turned on their headlights could have already turned them off. It also made interviewing more difficult because many of the drivers had forgotten about the HAR warning signs that they had seen five minutes earlier and had to be reminded before they remembered them. However, we do not feel

FIGURE 6

DATE_____

INTERVIEW QUESTIONNAIRE

HAR OPERATING? Y___ N___

1. NUMBER _____ 2. A.M.___ PM____ 3. INITIALS_____

4. HEADLIGHTS ON? Y___N___ 5. N.J. REGISTRATION? Y___ N___

6. ANTENNA TYPE: WINDSHIELD___FENDER: VERTICAL___SLANT___ BODY: VERTICAL___SLANT____

7. MAKE AND MODEL_____

GOOD MORNING (AFTERNOON). I'M WITH THE NEW JERSEY DEPARTMENT OF TRANSPORTATIO

WE'RE CONDUCTING A RESEARCH STUDY. DO YOU HAVE A FEW MINUTES TO ANSWER SOME QUESTIONS FOR US?

IF NO - ALL RIGHT. THANK YOU FOR STOPPING. BE CAREFUL ENTERING TRAFFIC.

IF YES, CONTINUE WITH SURVEY.

8. DID YOU SEE THE SIGNS ABOUT TRAFFIC ADVISORY RADIO? Y___ N___

9. DO YOU HAVE A WORKING AM RADIO IN YOUR CAR? Y___ N___

   IF NO GO TO QUESTION 17.

10. DID YOU TRY TO TUNE IN TO TRAFFIC ADVISORY RADIO? Y___N___

11. WERE YOU ABLE TO TUNE IN? Y___ N___

12. WAS IT EASY TO TUNE IN? Y___N___

13. WAS THE MESSAGE LOUD ENOUGH? Y___N___

14. DID YOU UNDERSTAND THE MESSAGE? Y___N___

15. DID THE MESSAGE HELP YOU IN DRIVING THROUGH THE CONSTRUCTION AREA? Y___ N___

16. HAVE YOU TUNED IN TO TRAFFIC ADVISORY RADIO IN THIS AREA BEFORE? Y___N___

17. WERE YOU AWARE OF TRAFFIC ADVISORY RADIO IN THIS AREA BEFORE TODAY? Y___N___

18. WHERE DID YOU GET ONTO I-80? _____

19. WHERE ARE YOU GETTING OFF OF I-80? _____

20. HAVE YOU TRAVELLED THROUGH THIS CONSTRUCTION AREA BEFORE? Y___N___

21. HAVE YOU BEEN INTERVIEWED HERE BEFORE? Y___ N___

THANK YOU FOR YOUR HELP. BE CAREFUL ENTERING TRAFFIC.

that this introduced any bias into the questionnaire data because 1) anyone who truly had not seen the signs would not have answered the questions, even if he claimed that he had seen them upon being prompted; 2) anyone who had seen the signs but forgotten them until prompted by the interviewer would at that time also remember what action he had taken with regard to tuning in to HAR; 3) anyone who had seen the signs and remembered them without prompting would also remember what action he had taken concerning tuning in to HAR.

The period during which interviews were conducted was dictated by a combination of factors which included the availability of police assistance, the availability of contractor's personnel to cover and uncover the warning signs, and the transportation of personnel and equipment to the data collection sites. The prime consideration, however, was to avoid collecting data during either morning or evening rush hour, for two very good reasons. First, the very heavy traffic during these two periods would have made it extremely dangerous to select and direct vehicles into the interview area. Second, the reduced number of lanes caused this heavy traffic to slow considerably, so that any traffic data obtained during rush hour(s) could not be compared to the data obtained at other times.

Despite the rather abbreviated hours available for interviewing (11 AM - 3 PM), we were able to obtain substantial samples for each of the four conditions listed at the beginning of this section. These sample sizes are listed in Table I, page 23.

TABLE I

NUMBER OF USABLE INTERVIEWS FOR EACH HAR CONDITION*

DATE	HAR ON 1	HAR ON 2	HAR ON 2L	HAR OFF
5/30/85	51	---	---	---
6/6/85	55	---	---	---
6/13/85	44	---	---	---
6/18/85	---	---	---	31
6/19/85	---	---	---	150
6/20/85	59	---	---	30
6/25/85	40	---	---	6
6/26/85	91	---	---	---
6/27/85	44	---	---	22
7/2/85	---	---	---	91
7/9/85	---	56	---	---
7/11/85	---	64	---	---
8/29/85	---	---	---	111
9/5/85	---	89	---	---
9/19/85	---	90	---	---
9/26/85	---	60	---	---
10/9/85	---	88	---	---
10/30/85	---	---	113	---
11/7/85	---	---	159	---
11/14/85	---	---	58	---
TOTAL	384	447	263	441

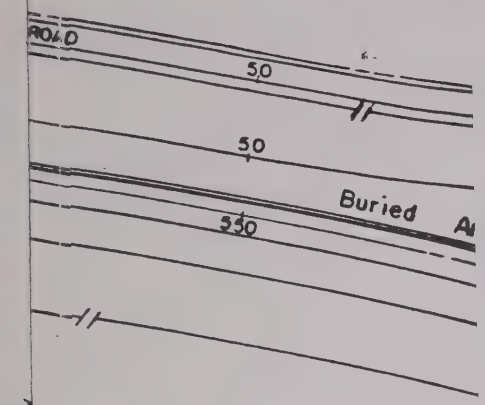
* Many of the drivers interviewed had entered I-80 west of the HAR advisory signs and antenna, so that there was no way they could have known about the message. These interviews were discarded.

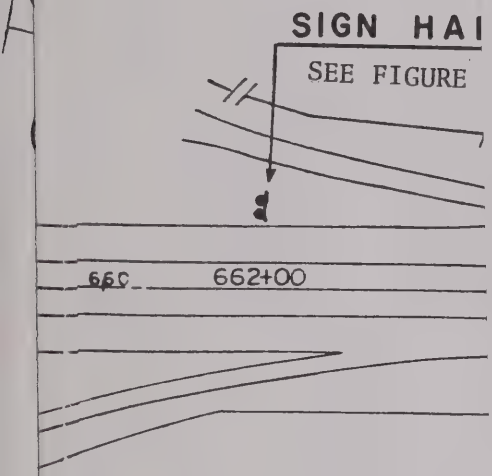
They were obtained over a total of 20 days of data collection, from May 30 through November 14, during which the interview periods varied from one to three hours, depending upon weather conditions and police availability.

Field Strength Readings - The first field strength readings were taken on May 15 and 20, 1985 in order to determine if the antenna output was in compliance with FCC regulations and to establish reference levels at a number of locations along the antenna. Further readings were taken at various intervals through June 10, 1986 at which time the system was shut down and dismantled. The locations at which field strength reading were taken are shown in Figure 7, page 25. The readings themselves are shown in Appendix VI, page 90.

During the 13-month period of operation the system was left on continuously, except for periods of malfunction, so that it was subjected to the full range of weather conditions in the area, which included temperatures ranging from -10 F to about 100 F. Humidity varied from about 35% to 100% during the period, and there were several violent thunderstorms during the summer of 1985. Lightning apparently disrupted both transmitter and recorder operation during these storms (despite the battery backup system in the recorder) at least three times over a four-week period in June and July. In addition to establishing compliance with FCC requirements and providing a standard, field strength measurements were also useful in helping to locate trouble areas when the system was malfunctioning.

ITENNA LOCATION AI





R - 3

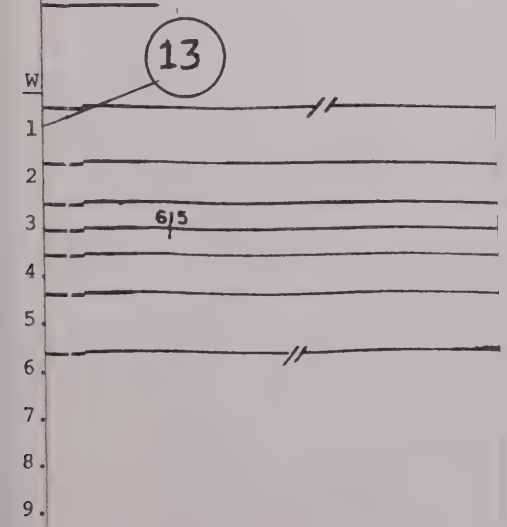
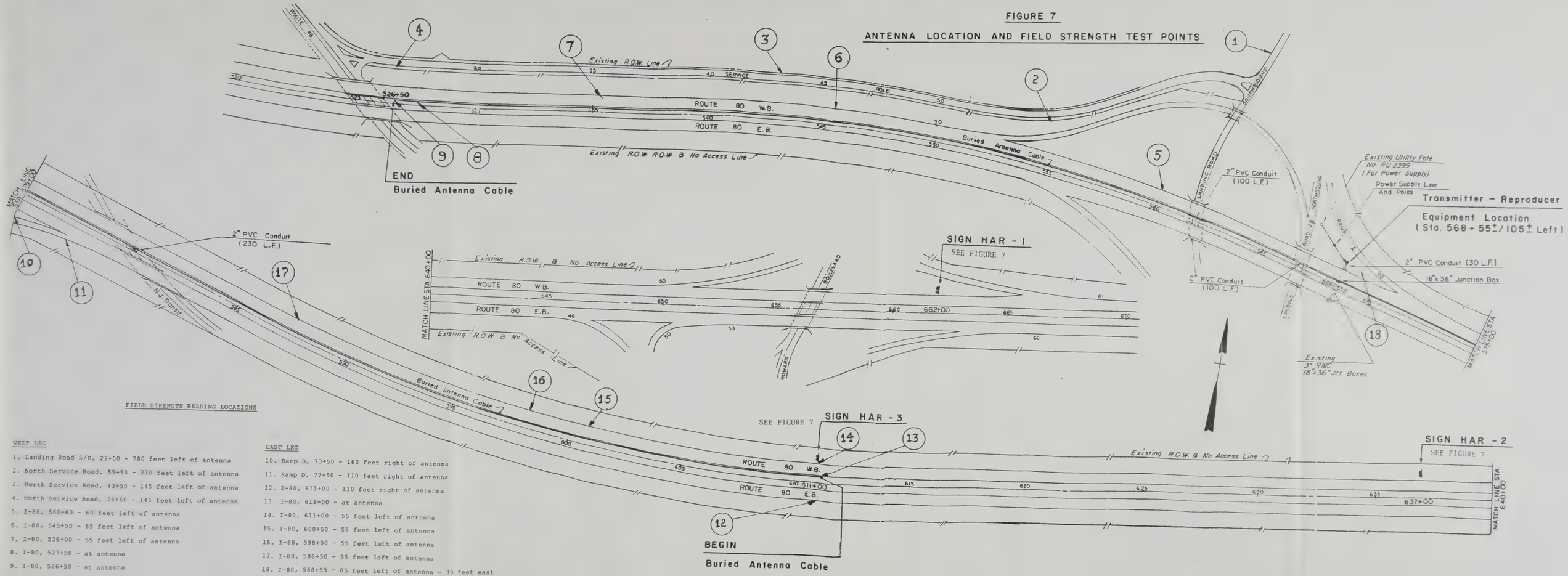


FIGURE 7

ANTENNA LOCATION AND FIELD STRENGTH TEST POINTS



FIELD STRENGTH READING LOCATIONS

WEST LEG

1. Landing Road S/B, 22+00 - 780 feet left of antenna
2. North Service Road, 55+50 - 210 feet left of antenna
3. North Service Road, 43+50 - 145 feet left of antenna
4. North Service Road, 26+50 - 145 feet left of antenna
5. I-80, 560+60 - 60 feet left of antenna
6. I-80, 545+50 - 65 feet left of antenna
7. I-80, 536+00 - 55 feet left of antenna
8. I-80, 527+50 - at antenna
9. I-80, 526+50 - at antenna

EAST LEG

10. Ramp D, 73+50 - 160 feet right of antenna
11. Ramp D, 77+50 - 110 feet right of antenna
12. I-80, 611+00 - 110 feet right of antenna
13. I-80, 611+00 - at antenna
14. I-80, 611+00 - 55 feet left of antenna
15. I-80, 600+50 - 55 feet left of antenna
16. I-80, 598+00 - 55 feet left of antenna
17. I-80, 586+50 - 55 feet left of antenna
18. I-80, 568+55 - 85 feet left of antenna - 35 feet east of transmitter

General Information - The project supervisor kept a of log of the varied and numerous problems with this system, both for research purposes and to assist the Resident Engineer of the construction project in determining whether or not to provide full payment to the contractor for the equipment and its maintenance. The information from this log was incorporated into two memoranda to the Resident Engineer. Examples of the type of information listed are: the failure of one or both cooling fans; failure of the recorder battery backup system; failure of the antenna due to ground moisture. These general items will be discussed more fully in the section entitled RESULTS AND DISCUSSION. The memoranda can be found in Appendix II, page 68.

DATA REDUCTION

Traffic Data - The videotapes taken prior to the start of construction, and those made during construction for the four conditions cited previously were viewed in the laboratory to obtain traffic counts by lane and vehicle type (light vehicles, trucks) and to determine the average speed of the two types of vehicles, also by lane. Speed was determined by timing the travel of vehicles between two marks placed on the roadway at each camera position. Using the stop-frame feature of the playback equipment and the clock superimposed on the tape (showing the nearest one-hundredth of a second) we obtained the travel time over the known distance for 10-15 vehicles of each type in each lane, for each hour. From this an average speed was calculated. Traffic counts were made using a hand-held counter while viewing the tapes at the most convenient speed. The tapes were nominally one hour long, but in some instances taping did not continue for the full hour because of rain, loss of police assistance, or system problems. In these cases the counts were prorated to one hour since the traffic volume did not vary substantially from day to day on the full-hour tapes. These prorated traffic counts can be found in Appendix III, page 77.

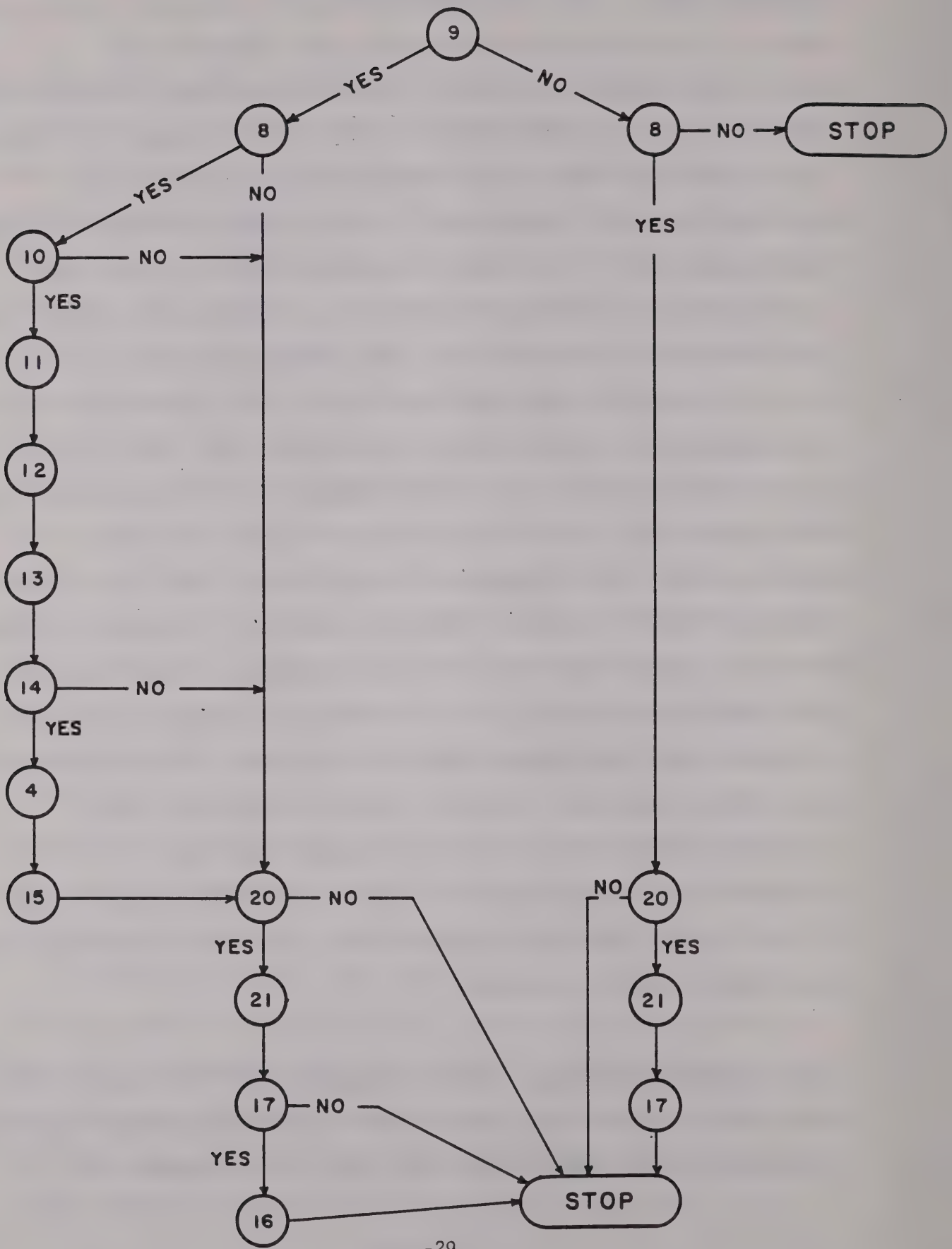
A third set of data from the tapes was a count of light vehicles passing Camera Location 2 with their headlights on. Since part of the message had been to "...turn on your headlights for safety." we hoped that the headlight count would reinforce the data from the interview sheets, which was the primary means of determining driver response to the system.

Interview Data - Reduction of the interview data was primarily a matter of tabulating the answers to each question and calculating the percentages of yes and no answers and their 95% confidence limits. Data reduction was not as simple as it would appear from this description however, since many of the questions were not independent of the others. In order to insure the independence of each set of answers (yes or no for each question) it was necessary to construct a series of "paths" for the tabulator to follow so that the number tabulated for a particular question was not based on the total number of drivers interviewed, but rather on the total number who could actually answer the question, based on the answers to the preceding ones. For instance, Q. 8 and 9 (See Figure 6, page 21 for the questionnaire) were independent of each other, but if a driver answered "no" to either of these he could not (logically) be expected to answer "yes" to Q. 10. Furthermore, a "no" on Q. 10 precluded his answering Q. 11 - 15 at all. Answers which were illogical were disregarded and not tabulated, for the particular question(s) involved. Figure 8, page 29 shows the data reduction "paths" followed in tabulating the data. In presenting the data analysis results in Table II, page 35 and the day-to-day listing in Appendix VII, page 91 we have used the same sequence as in Figure 8.

Field Strength Readings; General Information - Neither of these categories required any special data reduction process. Data and information from field notes were compiled as needed for

FIGURE 8

DATA REDUCTION PATHS



day-to-day operations, adjustment, and repair, and later put into finished form for the report.

DATA ANALYSIS

Traffic Data - To determine if there was a difference between the HAR ON and HAR OFF traffic data populations we used the Wilcoxon rank-sum test. This is a non-parametric test which can be used for very small as well as large samples. Since it does not depend upon the particular distribution of the data, there is no need to examine the data with regard to distribution, so that one can proceed directly to the application of the method.(1) The rank-sum test was also used to examine the homogeneity of the populations for the anwers to Q. 18 - 21 for both HAR ON and HAR OFF, and for the three subsets of HAR ON (HAR ON 1; HAR ON 2; HAR ON 2L).

In reporting the percentage of headlights on, no statistical analysis was undertaken because the number of drivers who complied was so small that any such analysis would have little meaning.

Interview Data - In analyzing the driver interview data for HAR ON, the primary statistical methods were those associated with the binomial distribution. This distribution is used where "pass-fail" or "yes-no" data is obtained. One of the criteria for binomially distributed data is that each observation be independent of the others. In one sense this condition was met if one considers the interview in toto as an observation, because the answers of one driver certainly did not influence

(1) Reference (7), pages 182 and 183

the answers of any other driver. On the other hand, it was not possible to achieve independence between all of the questions and therefore between all of the answers as given by any one driver. Thus it was necessary to follow a "path" (See Figure 8, page 29) and to use only the number who could logically answer in determining the percentage of yes or no anwers for each question. For some questions the actual number who could answer was quite small, especially when one considers that the smallest sample size is 330.

No analysis was undertaken to compare the "headlights on" (Q.4) data obtained prior to August 29 (the date that the interview site was moved) to that obtained from August 29 through November 14. As previously noted, this later data may be inaccurate to an unknown degree because of the considerable distance between the interview site and the construction area. The data is therefore included in Table II and Appendix III only for the sake of completeness.

For HAR OFF, only Q.18 - 21 were used in the interviews. Each of these was independent of the preceding question and of each other, so that we orginally thought that the data obtained could be compared to that for the HAR ON conditions. This comparison would have served to determine whether or not the interviewee population was the same in both cases, which in turn could have served to support the findings from the traffic data for the two types of conditions. However, moving the interview site placed us beyond the last interchange in the construction zone which eliminated one exit and added one entrance to I-80,

at the interview point. Thus any interview data obtained from August 29 through November 14 could be compared only with other interview and traffic data obtained during that period, and not with data obtained prior to moving the interview site.

Field Strength Readings; General Information - No specific statistical analysis was performed on the field strength data. The wide range of field strength readings evident in Appendix VI, page 90 and cited in the memos shown in Appendix II, page 68 are clear indications of the inconsistent performance of the system and the less-than-optimum maintenance by the electrical subcontractor. As a reference, the readings taken on 8/22/85 were about ideal in that they provided for a loud, clear, and intelligible message and were within the FCC limit of 2 millivolts at 60 meters from the antenna. Also note on page 75, paragraph four of Appendix II that the contractor failed to monitor the system and to keep a log of his findings, in violation of the specifications for the work.

RESULTS AND DISCUSSION

Driver Reaction to Advisory Signs - Table II, page 35 is a listing of the number of drivers (in percent) who answered various questions from the questionnaire. The percentages refer to the number of drivers who could answer in any particular case, which is not necessarily the same as the total number of drivers interviewed. It is clear from Q.8 that the signs highlighted by arrowboards (HAR ON 2L) used from 10/30 - 11/14/85 were far more effective than the previous sign configurations in attracting the attention of the drivers we interviewed. The ineffectiveness of HAR ON 1 became apparent early on and upon investigation we found that drivers in the middle and fast lanes often could not see the single set of signs on the rightside berm because of the large number of heavy trucks in the slow lane. This resulted in our experimenting with the intermediate step of placing a second set of signs in the median, opposite those on the berm. In testing for homogeniety of population between HAR ON 1, HAR ON 2, and HAR ON 2L for Q.8 it was clear that there was a definite increase in the percentage of drivers who saw the signs as a result of each change. In the case of driver response to the extent of tuning in to HAR however, (Q.10) there was no significant difference between HAR ON 1 and HAR ON 2, both averaging in the 20-21% range. This increased to around 40% for HAR ON 2L. While this is clearly an improvement over earlier driver response, viewing it from the negative side gives a better picture of what was really

TABLE II

RESULTS OF INTERVIEW DATA ANALYSIS BY SIGN CONFIGURATION

QUESTION	SIGNS	TOTAL INT.	YES	NO	TOTAL ANS.	%YES	%NO	95% C.L.
9	1	384	330	54	384	85.9	14.1	3.5
9	2	447	392	55	447	87.7	12.3	3.0
9	2L	263	249	14	263	94.7	5.3	2.7
8	1	384	207	177	384	53.9	46.1	5.0
8	2	447	304	143	447	68.0	32.0	4.3
8	2L	263	204	59	263	77.6	22.4	5.0
10	1	384	40	148	188	21.3	78.7	5.9
10	2	447	52	207	259	20.1	79.9	4.9
10	2L	263	79	119	198	39.9	60.1	6.8
11	1	384	23	15	38	60.5	39.5	15.5
11	2	447	26	24	50	52.0	48.0	13.8
11	2L	263	61	16	77	79.2	20.8	9.1
12	1	384	21	3	24	87.5	12.5	4.8
12	2	447	20	6	26	76.9	23.1	5.8
12	2L	263	50	10	60	83.3	16.7	9.4
13	1	384	21	3	24	87.5	12.5	12.9
13	2	447	25	1	26	96.2	3.8	7.2
13	2L	263	55	4	59	93.2	6.8	6.4
14	1	384	23	1	24	95.8	4.2	7.8
14	2	447	25	1	26	96.2	3.8	7.2
14	2L	263	55	1	56	98.2	1.8	3.5
4	1	384	4	19	23	17.4	82.6	15.1
4	2	447	6	19	25	24.0	76.0	16.3
4	2L	263	24	32	56	42.9	57.1	13.0
15	1	384	21	2	23	91.3	8.7	11.5
15	2	447	22	2	24	91.7	8.3	10.7
15	2L	263	64	20	84	76.2	23.8	9.1
20	1	384	269	115	384	70.1	29.9	4.6
20	2	447	280	168	448	62.5	37.5	4.5
20	2L	263	170	89	259	65.6	34.4	5.8
21	1	384	6	264	270	2.2	97.8	1.7
21	2	447	5	276	281	1.8	98.2	1.6
21	2L	263	10	161	171	5.8	94.2	3.5
17	1	384	46	211	257	17.9	82.1	4.7
17	2	447	36	218	254	14.2	85.8	4.3
17	2L	263	37	126	163	22.7	77.3	6.4
16	1	384	16	25	41	39.0	61.0	14.9
16	2	447	7	13	20	35.0	65.0	20.2
16	2L	263	12	20	32	37.5	62.5	16.8

SIGNS: 1 = HAR ON 1; 2 = HAR ON 2; 2L = HAR ON 2L.
TOTAL INT. is the total number of drivers interviewed for each sign condition.
TOTAL ANS. is the total number of drivers who could answer.
95% C. L. = 95% confidence limits; all are + or - indicated percent.

happening: about 60% of the drivers who saw the signs were not tuning in to HAR. Although we did not question these drivers as to their reasons for not tuning in to HAR, many of them volunteered the information. Some of the most often repeated reasons were: a) Driver does not normally listen to AM radio; b) Children in car were listening to rock music tapes or rock music station; c) Driver was listening to tapes or FM radio; d) Occupants of car were talking; e) Traffic was moving normally when driver saw the signs (nearly two miles east of the construction area!) so there was no need to tune in; f) Driver was not in a rush. Thus it appears that driver reaction to the signs was based on emotional rather than intellectual considerations. In view of the variety of potentially hazardous situations or delays of unknown duration which could have been present as a result of the construction, none of which could have been seen from the HAR warning sign area, it is disappointing to find that 60% of the drivers preferred to continue with the activities of the moment rather than interrupt them for 90 seconds (at most) to listen to HAR and perhaps make their trips a little safer or smoother.

Effectiveness of HAR as a Traffic Control Device - In comparing speed data from before and during construction, and between HAR OFF and the three HAR ON conditions, we found that there was no significant difference. Apparently HAR did nothing to help reduce speeds in the construction zone, any more than the posting a 40 mph limit did. Driver apathy toward traffic control

devices in general and disregard of posted speed limits and warnings in particular is certainly not a new phenomenon, nor is it peculiar to construction zones. It is common to see drivers ignoring road conditions, sometimes until they are required to make some unplanned last-minute (often hazardous) maneuver to avoid an accident. However, in this instance such inattention is to some degree understandable. The approach to the construction area was along a 6-lane section of I-80 in an scenic rural area. Although there were many signs warning of the construction area in addition to the HAR broadcast, there was little in the construction zone itself which would cause drivers to reduce speed. Thus reducing the speed limit from 55 to 40, and the westbound lanes from 3 to 2 had little effect since the drivers were still moving along a well-surfaced interstate highway with no detours or sharp curves, in an attractive rural setting. Although the start of the construction area was on a moderately steep uphill slope there was very little slowdown during the day except when truck traffic was relatively heavy. Even then this was so slight that there was almost no backup to the east of the construction zone. Therefore incoming drivers usually had no reason to slow to 40 mph, so that even those who had tuned in to HAR and/or had seen the speed limit signs tended to continue along with the mass of traffic at whatever speed seemed appropriate.

We can make no recommendation which would alleviate this situation. Rigid enforcement of the speed limit in such a setting would have been impractical and would have created

problems where none existed before (from the aspect of a smooth and rapid flow of traffic). The conditions within the construction zone itself regulated vehicle speed and since the conditions were not restrictive drivers tended to maintain speeds well above the posted 40 mph limit.

Neither can we make any recommendation to overcome driver apathy in tuning in to HAR. Judging from the reasons volunteered by those who did not avail themselves of the information being broadcast, the pleasant rural setting played a rather small part in their ignoring the HAR warning signs. There is no way to insure that motorists will take advantage of assistance that is provided for them, and no way to provide assistance without the cooperation of the motorists. Therefore the effectiveness of HAR, or any other type of highway assistance, is determined for the most part by the personalities of those for whom it is meant to serve, once it is in place and functioning correctly.

Effectiveness of the HAR Message - Another aspect of driver apathy toward HAR was the content of the message. Because it was designed primarily to yield experimental data and secondarily to provide driver assistance, the message was such that drivers tuning in received little more than a general alert and a request to be careful. Furthermore the message was the same for all HAR ON conditions since changing it for any reason would have introduced a variable of unknown effect, especially for Q.14 and Q.15. Thus anyone who had listened to HAR while passing the west end of the antenna had received this rather vapid

message, while simultaneously being able to see that traffic already in the construction zone was still moving at the same speed with no indication of congestion, hazard, or police ahead. Therefore the message itself may have contributed to the ineffectiveness of HAR since it provided a warning which was usually not in keeping with those traffic and road conditions visible from the west end of the HAR transmission area. Thus there may have been more incentive to ignore the message than to comply with it. This is supported by inspecting the data in Appendix III, pages 77-85. The number of light vehicles per hour with headlights on (the number in parentheses) is less than 1 % for 92 of the 93 hour-long traffic observations. It is slightly more than 1 % for the remaining observation. Obviously most of the 20 % - 40% of the drivers who tuned in to HAR did not comply with the request for headlights any more than they complied with the 40 mph speed limit. Apparently they believed that there was neither an advantage to be gained by complying nor a penalty to be suffered for not complying. In short, it is reasonable to infer that the message provided no incentive for drivers to comply with either request and as a result it was one of the reasons that HAR was ineffective.

Equipment Reliability - Concerning the equipment, we found little to recommend it except its ease of use. Its numerous failures are documented in Appendix II, page 68. One major drawback to a buried antenna is the difficulty in pinpointing problems, especially if it is not installed with maintenance in

mind. Although the specifications required that each leg of the antenna be continuous, the radio subcontractor found that each leg had to be grounded at its midpoint in order to obtain a usable signal. Unfortunately his personnel did not mark these locations, so that when problems developed and the grounds were suspected these same technicians spent hours digging in the median looking for the them. Another problem with this type of antenna is that there is a high potential for damage if it is buried close to the roadway. It is not unusual to find deep gouges in the berm or median alongside any highway as a result of heavy trucks running off the pavement and tearing up the soil. Assuming that a 12-inch depth is typical for this type of antenna, it is not unreasonable to think that it might be damaged as a result of such minor accidents. There were two instances in which this appeared to have occurred on this project. Although there was no damage to the antenna in either case, it was necessary to dig it up to inspect it in one of these instances, which was a time-consuming effort. Furthermore, if the cable had been damaged it would have been necessary to splice it at that point, which probably would have further compounded the problems with the system, especially when the ground was wet.

Overview and Recommendations - Inspection of the field strength readings shown in Appendix VI, page 90 clearly shows the inconsistent performance of the system. Part of the problem was certainly the effect of ground moisture on the antenna, which

caused static as well as a weaker signal. Transmitter problems also resulted in weaker signals on occasion, but recorder problems were generally indicated by an "on or off" condition, so that a complete lack of signal usually indicated recorder failure.

To recap, we do not consider that HAR was a useful or cost-effective device in this setting, which for the most part was relatively free of hazards and conditions which could cause delays (see above). At a final cost of $85,000, there is no indication that it provided for or added to the traffic control or safety already resulting from the usual signs and other devices normally used in construction areas. The HAR ON conditions were in effect only when the research project supervisor felt that the system output was acceptably strong and clear, so this assessment does not take into account the many equipment malfunctions which occurred during the six months that interview and traffic data were collected. If, on the other hand, HAR had been effective the system would still have been unacceptable because of the unreliability of the particular equipment used. Since HAR was not useful in this setting and there was no indication that the equipment would have been any more reliable in a different locale we conclude that 1) HAR should not be used in conjunction with construction projects unless it can be utilized to provide continuously updated and useful information to the motorist, in a situation where traffic pressure is great enough to provide an incentive to tune in to

the broadcasts; 2) Any HAR system so utilized must be demonstrably reliable under conditions similar to those to be encountered, and proven to be so prior to its installation on the project.

REFERENCES

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(5) Highway Advisory Radio in the Philadephia Area, E. G. Brizell and N. L. Veale; Delaware Valley Regional Planning Commission, Philadelphia, Pa. Report Number FHWA-RD-78-77 April, 1978

(6) Highway Advisory Radio Operational Site Survey and Broadcast Equipment Guide, Warren F. Dorsey; Systems Development and Technology Group, FHWA Report Number FHWA-RD-79-87 April, 1979

(7) Introduction to Probability and Statistics, Henry B. Adler and Edward B. Roessler; W. H. Freeman and Co., San Francisco Fifth Edition, 1972

(8) Nonparametric Statistical Methods, Myles Hollander and Douglas A. Wolfe; John Wiley & Sons, New York 1973

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(11) SAS/STAT Guide for Personal Computers Version 6 Edition, SAS Institute Inc.,Cary, N. C. 1987

(12) SAS User's Guide: Statistics Version 5 Edition, SAS Institute, Inc., Cary, N. C. 1985

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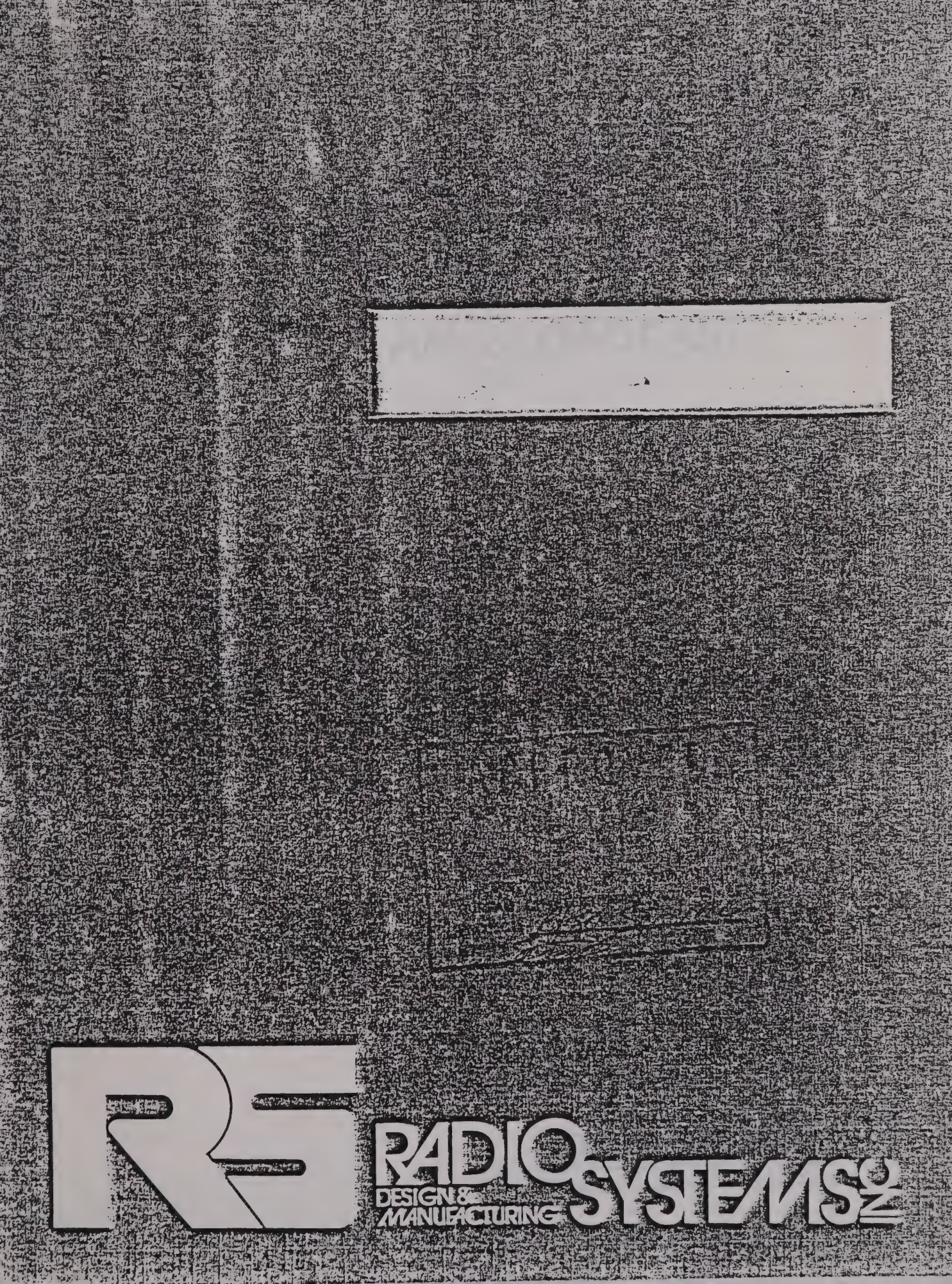
APPENDIX I

LIST OF EQUIPMENT AND SPECIFICATIONS


RADIO SYSTEMS
DESIGN & MANUFACTURING

AM BROADCAST

ITEM 147

Daniel Braverman
President

RADIO SYSTEMS
5113 WEST CHESTER PIKE • EDGEMONT, PA 19028 • 215/356-4700

Rt 80 Section 1 AL, 6 G, and 7 H
Highway Advisory Radio

"As Equal or Better"
Equipment Substitutions

Transmission System Design Modifications

System will utilize two 20 watt transmitters, each providing power in one direction from the center feed point. This will provide up to twice the available radio power and allow independent power adjustments up the left and right antenna "legs."

This systems design eliminates the need for a splitter unit and any underground splices.

A systems block diagram is attached.

Page #84 Metal Cabinet

No specific unit is specified. The Hoffman #A-42H30BLP cabinet, in conjunction with A-PA4AXFN fans with A-EXGR4 filters and A-GARD4 finger guards, will be utilized. It meets all environmental specifications and is of sufficient size to house the transmitters and recorder/reproducer. A steel shelf will be fabricated and fitted in the cabinet to isolate audio and transmission equipment. Catalogue sheets on this unit are attached.

Page #84 Radio Transmitter

The Radio Systems model TR-20 TIS will be substituted as an equal unit. It meets all stated specifications and is type accepted for TIS use. Catalogue sheets are attached.

Page #84 Antenna Cable

The Radio Systems model RA-9 cable is substituted as an exact equal for the LPB NF-2P radiating cable.

Catalogue sheets are attached.

RADIO SYSTEMS
5113 WEST CHESTER PIKE • EDGEMONT, PA 19028 • 215/356-4700

Rt 80 Section 1 AL, 6 G, and 7 H
Highway Advisory Radio

"As Equal or Better"
Equipment Substitutions

Page #86 Recorder/Reproducer

The Cook model 21330 solid state announcer is substituted as a superior product to those specified. It will be provided with 32 seconds of recording/playback time and utilizes at 32 kHz sampling rate for superior performance.

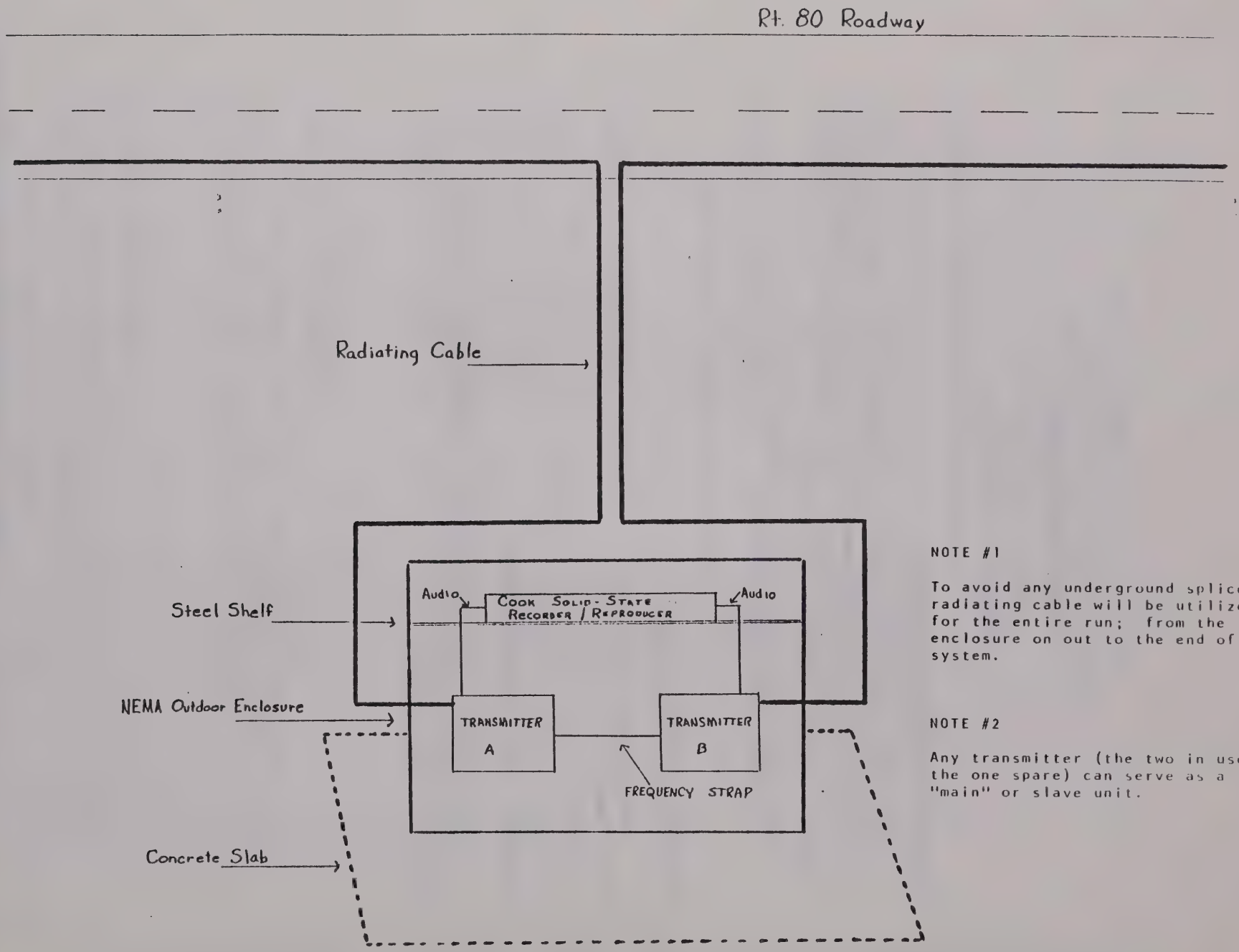
Catalogue sheets are attached.

Page #87 Antenna Splitter

The antenna splitter is deleted. See overall system modifications for explanation.

Page #87 Field Strength Meter

The Potomac model FIM-21, by the manufacturer modified for 530 kHz reception, is selected for use to make required field strength measurements.

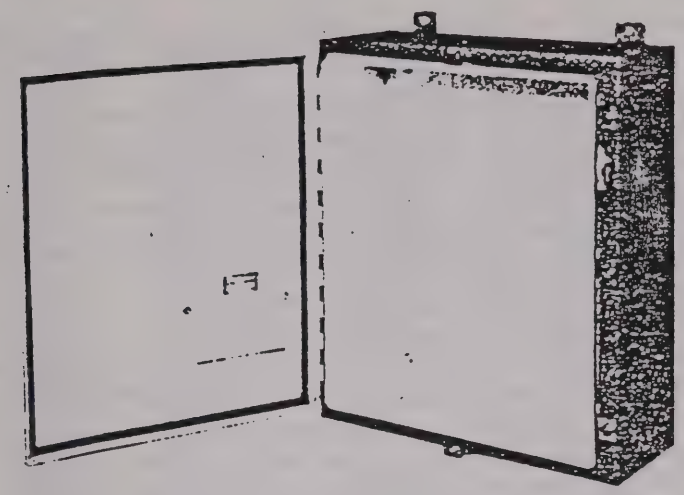


NOTE #1

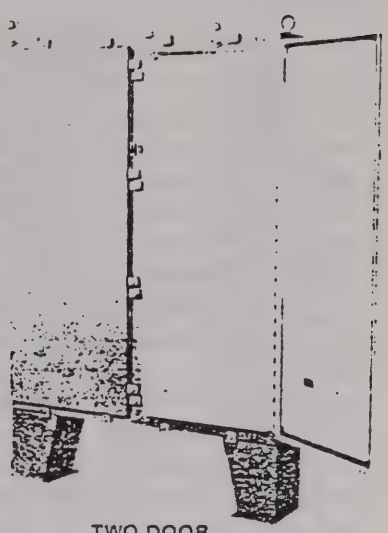
To avoid any underground splices, radiating cable will be utilized for the entire run; from the enclosure on out to the end of the system.

NOTE #2

Any transmitter (the two in use or the one spare) can serve as a "main" or slave unit.



SINGLE DOOR



TWO DOOR

APPLICATION — Hoffman NEMA Type 4 Enclosures are designed to house electrical controls, terminals, and instruments in areas which may be regularly hosed down or are otherwise very wet. They are suitable for use in dairies, breweries, and similar installations.

CONSTRUCTION —

SINGLE DOOR ENCLOSURES — Made from 14 gauge steel and have a strong and rigid construction. All seams are continuously welded and there are no holes or knockouts. A rolled lip is provided around three sides of the door and around all sides of the enclosure opening; this lip increases strength and keeps dirt and liquids from dropping into the enclosure when the door is opened. Neoprene gasketing insures a watertight seal around the door opening. The gasket is attached with oil-resistant adhesive, and is also held in place with steel retaining strips. The door clamps are quick and easy to operate, and have no loose parts. All exterior hardware (such as clamps, clamp screws, hinge pins, etc.) is stainless steel. The door can be removed by pulling the hinge pin. A hasp and staple are provided for padlocking, and each enclosure has a removable and reversible print pocket. Body stiffeners and door stiffeners are provided in larger enclosures for extra rigidity. External feet are furnished for mounting. Collar studs are provided for mounting the optional panels. PANELS MUST BE ORDERED SEPARATELY.

TWO DOOR ENCLOSURES — All enclosures are made from 12 gauge steel (except the enclosure back is 14 gauge when A=74 1/16). All seams are continuously welded and there are no holes or knockouts. A rolled lip is provided around three sides of the door and along the top of the enclosure opening; this lip increases strength and keeps dirt and liquids from dropping into the enclosure when the door is opened. Clamps are provided on three sides of each door to insure a watertight seal with the neoprene gaskets. The gaskets are attached with oil-resistant adhesive, and are also held in place with steel retaining strips. All exterior hardware (such as clamps, clamp screws, hinge pins, etc.) is stainless steel. A heavy gauge continuous hinge supports each door. The center-post is removable to permit easy panel installation.

A hasp and staple are provided on each door for padlocking, and each enclosure has a removable print pocket. All two door enclosures have 12 inch floor stands, heavy-duty lifting eyes, and "X-form" body stiffeners. Collar studs are provided for mounting the optional panels. Panel supports are provided to support panel and aid in panel installation. PANELS MUST BE ORDERED SEPARATELY.

ACCESSORIES --

PANELS — Panels must be ordered separately as they are not furnished with the enclosures. Panels for single door enclosures are 12 gauge steel; panels for two door enclosures are 10 gauge steel.

FLOOR STAND KITS — Floor stand kits in 6 inch, 12 inch, 18 inch, and 24 inch heights are available for factory or field installation on single door NEMA 4 enclosures. See Bulletin A-80 for details.

TERMINAL KIT ASSEMBLIES — Bracket assemblies and terminal straps are available for mounting terminal blocks. See Bulletin A-80 for details

ELECTRICAL INTERLOCKS — Hoffman electrical interlocks provide a positive internal safety lockout on electrical enclosures while the enclosure contents are energized. See Bulletin A-80 for details.

MISC. ACCESSORIES — Other accessories include oil-tight hole seals, touch-up paint, gasketed hubs, window kits, rack angle kits, panel support kits, lock kits, and enclosure stabilizers. See Bulletin A-80 for details.

FINISH — The standard finish is white enamel inside and gray prime outside over phosphatized surfaces. Panels are white enamel. Additional finishing of the exterior is necessary if the enclosure is located in a wet area. Hoffman can supply special finishes upon request; consult the factory for prices.

MODIFICATIONS -- Hoffman can supply holes, hubs, louvers, cutouts, special finishes, special materials, special enclosure sizes, and many other modifications. Consult the factory for prices.

INDUSTRY STANDARDS -- Conform to the National Electrical Manufacturers Association (NEMA) standard for Type 4 (Watertight and Dusttight), Type 12 (Industrial Use), and Type 13 (Oiltight and Dusttight) enclosures. They also conform to Joint Industrial Council (JIC) standard EGP-1-1967. Special finishes may be required to meet specific environmental conditions. All of the enclosures shown on the following page are listed by Underwriters' Laboratories, Inc. For current Canadian Standards Association (C.S.A.) listings, consult the factory.

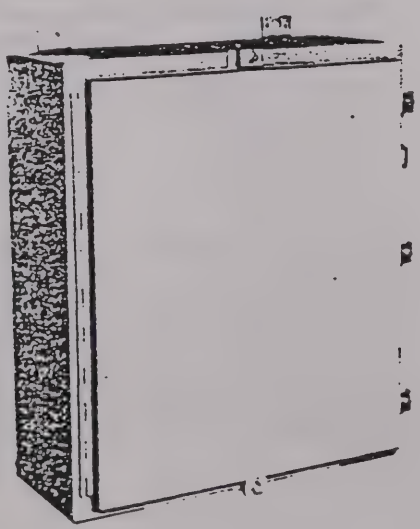
STANDARD SIZES

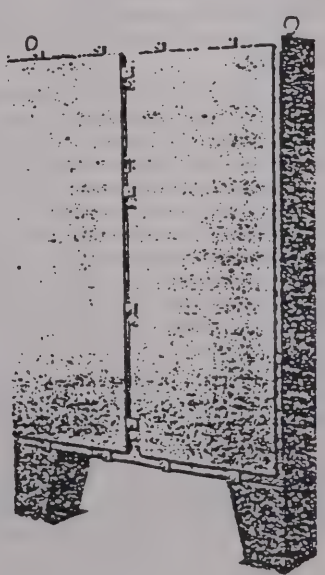
Enclosure Catalog Number	Enclosure Size A x B x C	*Panel Catalog Number	Panel Size
A-16H12ALP	16 x 12 x 6	A-16P12	13 x 9
A-16H16ALP	16 x 16 x 6	A-16P16	13 x 13
A-16H20ALP	16 x 20 x 6	A-20P16	17 x 13
A-20H16ALP	20 x 16 x 6	A-20P16	17 x 13
A-20H20ALP	20 x 20 x 6	A-20P20	17 x 17
A-24H12ALP	24 x 12 x 6	A-12P24	9 x 21
A-24H16ALP	24 x 16 x 6	A-24P16	21 x 13
A-24H20ALP	24 x 20 x 6	A-24P20	21 x 17
A-24H24ALP	24 x 24 x 6	A-24P24	21 x 21
A-30H20ALP	30 x 20 x 6	A-30P20	27 x 17
A-30H24ALP	30 x 24 x 6	A-30P24	27 x 21
A-36H24ALP	36 x 24 x 6	A-36P24	33 x 21
A-16H12BLP	16 x 12 x 8	A-16P12	13 x 9
A-20H16BLP	20 x 16 x 8	A-20P16	17 x 13
A-20H20BLP	20 x 20 x 8	A-20P20	17 x 17
A-20H24BLP	20 x 24 x 8	A-24P20	21 x 17
A-24H20BLP	24 x 20 x 8	A-24P20	21 x 17
A-24H24BLP	24 x 24 x 8	A-24P24	21 x 21
A-24H30BLP	24 x 30 x 8	A-30P24	27 x 21
A-30H20BLP	30 x 20 x 8	A-30P20	27 x 17
A-30H24BLP	30 x 24 x 8	A-30P24	27 x 21
A-30H30BLP	30 x 30 x 8	A-30P30	27 x 27
A-36H24BLP	36 x 24 x 8	A-36P24	33 x 21
A-36H30BLP	36 x 30 x 8	A-36P30	33 x 27
A-42H30BLP	42 x 30 x 8	A-42P30	39 x 27
A-42H36BLP	42 x 36 x 8	A-42P36	39 x 33
A-48H36BLP	48 x 36 x 8	A-48P36	45 x 33
A-60H36BLP	60 x 36 x 8	A-60P36	57 x 33
A-20H16CLP	20 x 16 x 10	A-20P16	17 x 13
A-24H20CLP	24 x 20 x 10	A-24P20	21 x 17
A-30H24CLP	30 x 24 x 10	A-30P24	27 x 21
A-36H30CLP	36 x 30 x 10	A-36P30	33 x 27
A-48H30CLP	48 x 30 x 10	A-48P30	45 x 27
A-48H36CLP	48 x 36 x 10	A-48P36	45 x 33
A-60H36CLP	60 x 36 x 10	A-60P36	57 x 33
A-30H24DLP	30 x 24 x 12	A-30P24	27 x 21
A-36H30DLP	36 x 30 x 12	A-36P30	33 x 27
A-48H36DLP	48 x 36 x 12	A-48P36	45 x 33
A-36H30FLP	36 x 30 x 16	A-36P30	33 x 27
A-48H36FLP	48 x 36 x 16	A-48P36	45 x 33
A-60H36FLP	60 x 36 x 16	A-60P36	57 x 33

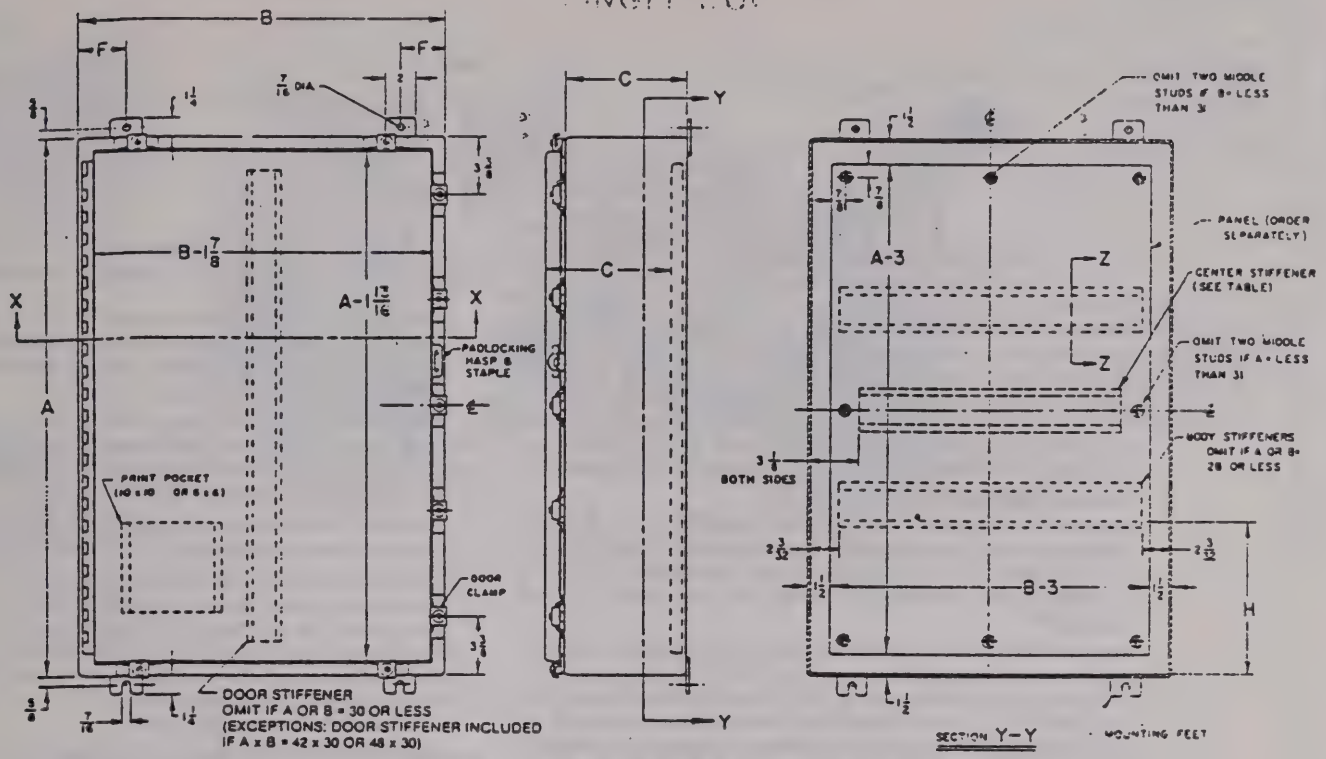
*Panels must be ordered separately.

Enclosure Catalog Number	Enclosure Size A x B x C	Enclosure Steel Gauge	*Panel Catalog Number	Panel Size	Panel Steel Gauge
A-62H48CLP	62 1/16 x 48 1/16 x 10 1/16	12	A-60P48	56 x 44	10
A-62H60DLP	62 1/16 x 60 1/16 x 12 1/16	12	A-60P60	56 x 56	10
A-74H60DULP	74 1/16 x 60 1/16 x 12 1/16	12+	A-72P60	68 x 56	10
A-74H72DULP	74 1/16 x 72 1/16 x 12 1/16	12+	A-72P72	68 x 68	10
A-74H72JULP	74 1/16 x 72 1/16 x 24 1/16	12+	A-72P72	68 x 68	10

*Panels must be ordered separately.
+Enclosure backs are 10 gauge.

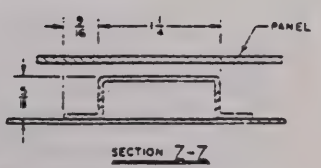


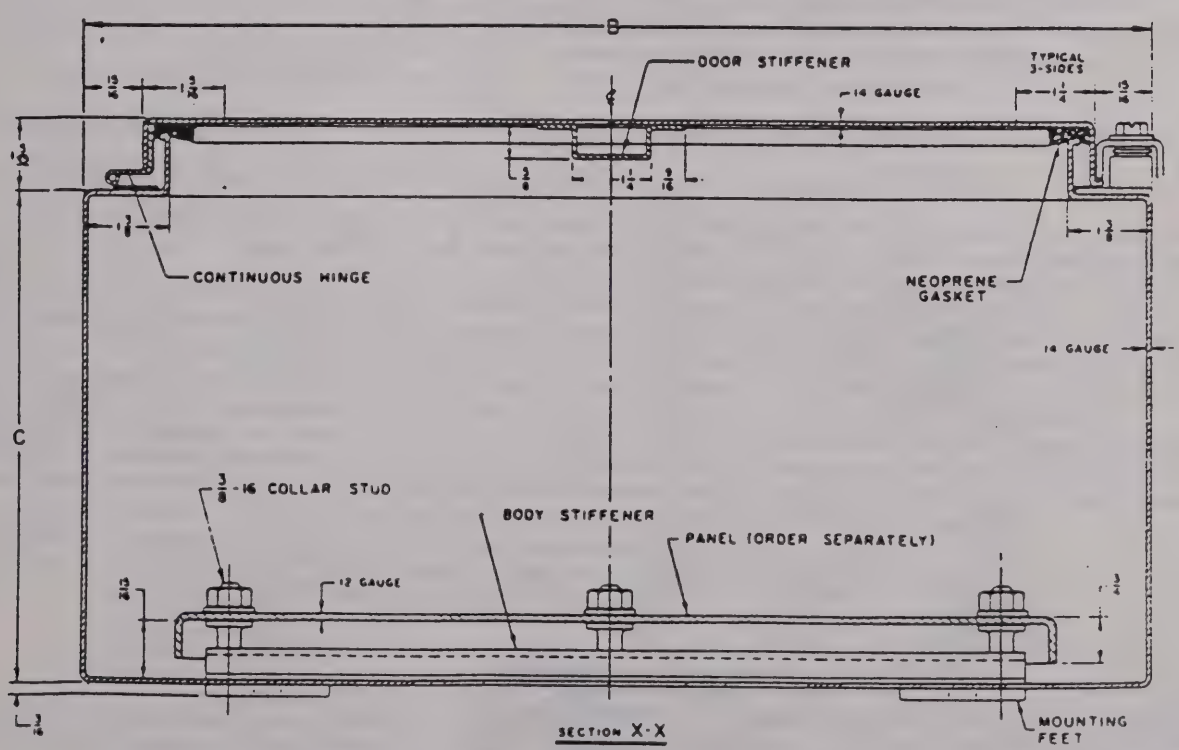




NOTE:
1. F = 3 when B is 16 or more: F = 1¼ when B is less than 16.
2. Large print pocket furnished if A = 30 or more and B = 20 or more.
3. The number of door clamps is dependent on size of enclosure. Clamps are furnished along 3 sides of door. Maximum spacing between door clamps is approximately 15 inches.
4. Panels have flanges along sides which are more than 17 inches long.

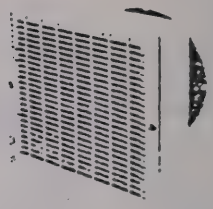
A x B	H	CENTER STIFFENER
30 x 30	7	NOT INCLUDED
36 x 30	9	NOT INCLUDED
42 x 30	9¾	INCLUDED
42 x 36	9¾	INCLUDED
48 x 30	13	NOT INCLUDED
48 x 36	11¾	INCLUDED
60 x 36	14¾	INCLUDED





100 CFM FAN PACKAGE
Cat. No. A-PA4AXFN

240 CFM FAN PACKAGE
Cat. No. A-PA6AXFN



560 CFM FAN PACKAGE
Cat. No. A-PA10AXFN

APPLICATION — Hoffman Cooling Fan Packages are particularly useful in enclosures where space is limited, and complete reliable cooling systems are needed. These ready-to-install cooling packages deliver large volumes of filtered air with minimum intrusion into the cabinet. They are available in three sizes to handle air flows of 100, 240 and 560 cubic feet per minute (CFM). They operate on 115 Volt AC, 50/60 Hertz (Hz), single phase input power.

Hoffman fan packages easily mount against the top, bottom, sides or doors of enclosures. The fans are reversible; cool air may be drawn into the cabinet or hot air pushed out. The same Hoffman fans described on page 160 are used in these packages.

CONSTRUCTION — The Hoffman fan packages consist of four main components: fan, air plenum, filter and grille. Fan features are covered on page 160. The air plenum is specially designed to provide optimum fan performance and broad air distribution while occupying minimum space. It is made of 16 gauge cold rolled steel.

The washable aluminum filter, behind the grille, provides good arrestance of airborne dirt with little pressure drop. It is constructed with 12 layers of expanded aluminum, providing hundreds of adhesive-coated baffle surfaces for trapping particles

The grille is made of 16 gauge stainless steel. It is attractively styled, easy to remove, and designed with numerous narrow slots for safety. A finger guard and all necessary mounting hardware are included with each package.

FINISH — The stainless steel grille is polished. The plenum is white enamel inside and out. Fan housing is black.

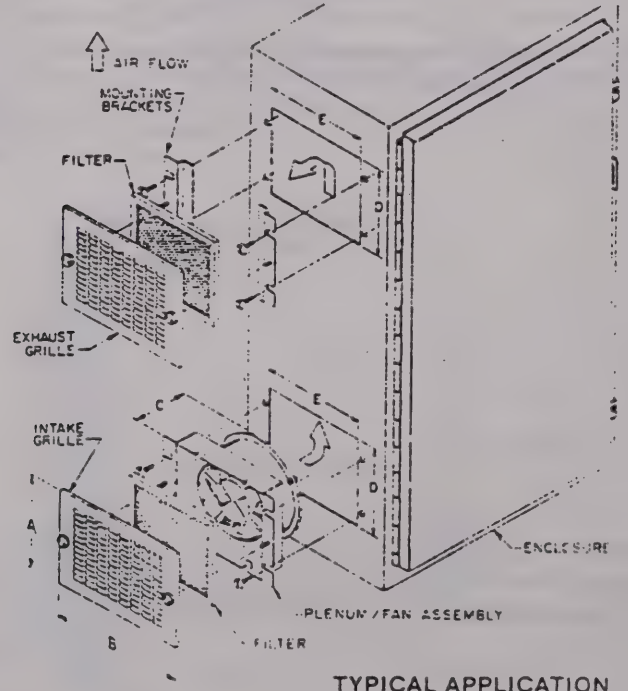
INSTALLATION — The fan packages can be easily installed in the field by making a cut-out of the proper size and mounting the plenum/fan assembly. They can be operated in any position, but for longer lasting operation, the fans may be mounted at the cooler air inlet side, as shown in the sketch below. The Hoffman fan packages require no special maintenance, but the filters should be kept clean

INDUSTRY STANDARDS — All fans are U.L. component recognized and C.S.A. certified. Consult with U.L. or C.S.A. if you need listing of the entire enclosure system

SPECIFICATIONS AND PERFORMANCE DATA

Fan Package Catalog Number	Dimensions A x B x C	CFM	VAC	Hz	Amps	Watts	Motor RPM	Service Temp. (°C)	Service Temp. (°F)	Noise* S.I.L. (db)	Weight (lb.)
A-PA4AXFN	6.1 x 7.4 x 3.8	100	115	60	.28	19	3,000	25	77	38	3.8
A-PA6AXFN	7.6 x 8.9 x 5	240	115	60	.25	29	3,400	50	122	50	4.7
A-PA10AXFN	11.6 x 13 x 8	560	115	60	.35	36	1,650	65	149	46	10.9

* S.I.L. (db) — Speech interference level in decibels. Effect of noise upon speech intelligibility is determined by averaging the readings at three octave bands (500Hz, 1000Hz, 2000Hz).



TYPICAL APPLICATION

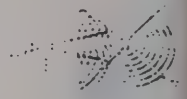
ACCESSORIES

GRILLE AND FILTER — One grille and filter are included with each fan package. An additional grille and filter are normally required for each installation as shown in the drawing. The 16 gauge stainless steel grille is designed for safety and low resistance to air flow (63% open). All necessary mounting hardware is included.

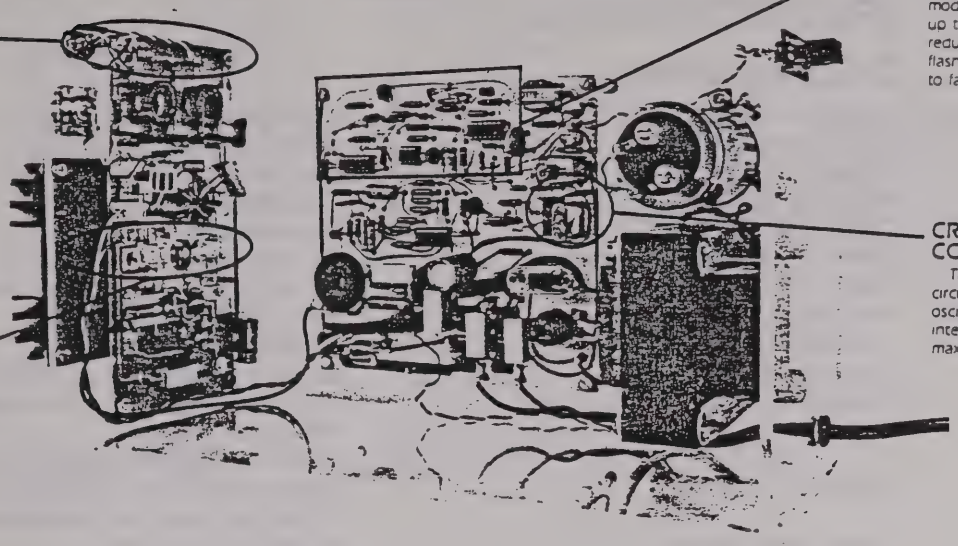
Grille and Filter Cat. No.	Grille Size A x B	Filter Size	Cut-Out D x E
A-EXGR4	6.1 x 7.4	5.28 square	5.8 x 5.8
A-EXGR6	7.6 x 8.9	6.88 square	7.3 x 7.3
A-EXGR10	11.6 x 13	10.88 square	11.3 x 11.3

FINGER GUARDS — One finger guard is included with each fan package. An additional finger guard can be mounted on either side of the fan for maximum safety. All guards are chrome plated and meet U.L. 507, ¼ inch plug gauge test

Finger Guard Catalog No.	Used on Fan No.
A-GARD4	A-4AXFN
A-GARD6	A-6AXFN
A-GARD10	A-10AXFN



OPTIONS — Replacement filters are available. Fan packages can be factory installed. Consult the factory for installation charges


DETECTOR CIRCUIT
The final output of the transmitter is demodulated so that a failure anywhere in the chain will be detected. The audio output of this circuit is available on a standard headphone jack
AUDIO LIMITER AND LED PEAK FLASHER
Internal audio limiter circuitry eliminates over-modulation by providing up to 20 dB of gain reduction. An LED flashes on audio peaks to facilitate gain set-up
CRYSTAL CONTROLLED
The crystal oscillator circuit utilizes a single oscillator/counter integrated circuit for maximum reliability
OUTPUT TRANSISTORS
Diffused emitter transistors are utilized for their capability of withstanding high S.W.R conditions.

THE "PHASE II" TR-20 TRANSMITTER

Radio Systems' "Phase II" transmission equipment has been designed, tested and proven for low power, AM broadcast applications.

Today, over 800 units are providing dependable service for college broadcast stations, drive-in theaters and other specialized broadcast functions. "Phase II" equipment has been type accepted by the Federal Communications Commission for Travelers Information Services and by the Department of Communications for Canadian use.

This solid state, 20 watt system utilizes high power output devices and a stable, regulated power supply for dependable performance. State of the art design renders high fidelity AM sound with extended frequency response. Specialized circuitry such as internal audio limiting and output monitoring, is incorporated for increased flexibility.

Ultra reliability, audio performance and unique features have made the TR-20 the new accepted standard in low power, AM broadcast transmission.

MAXIMUM MODULATION

AM radio is always fighting high background noise levels, so maximum audio modulation is important for the best possible signal to noise ratio.

The TR-20 has an internal 100% peak modulation limiter which automatically controls the transmitter gain to stop over-modulation distortion. The limiter has a full 20 dB gain reduction range and has a switch to defeat its operation for non-automatic use. Limiting action is controlled by input gain level setting.

A peak modulation LED flasher is also incorporated to aid in level and limiter action set-up

OUTPUT CIRCUITRY

The TR-20 is a totally solid state unit and benefits from the extended frequency response and stability of transistors through the final output stage.

Extremely dependable and long life operation is achieved by utilizing Class AB circuitry and defused emitter output transistors, capable of withstanding high VSWR conditions. Additional protection is achieved by fuse protecting the transistors from drawing too much current, and automatic temperature regulating of the final state.

A two stage, exciter-amplifier approach is used to insure that electronic operation is unaffected by external load factors.

MONITORING

The TR-20 output can be monitored through its built-in audio detector circuit. These components effectively comprise a miniature radio whose audio output is provided on a phone jack on the side of the transmitter. Headphones can be utilized for on-site monitoring, or the signal can be wired to remote amplifier.

Because the detector monitors the signal envelope at the final output of the transmitter, performance of the entire audio chain can be evaluated.

RS RADIO SYSTEMS
DESIGN & MANUFACTURING

5131 WEST CHESTER PIKE. EDGEMONT. PENNSYLVANIA 19028 (215) 356-4700

SPECIFICATIONS

TR-20 Transmitter

R.F. Power Output	Adjustable to 20 watts
Type of Emission	Amplitude Modulation (A3)
Frequency Range	500 kHz to 1.7 MHz
Frequency Stability	± .002% (0° to 35°C)
Carrier Shift	2% maximum
Harmonic Attenuation	45 dB or better
Noise	-60 dB below 100% modulation
Audio Input	600 ohms balanced
(for 100% modulation)	-30 dBm minimum
Frequency Response	20 Hz to 15 kHz ±1.0 dB maximum
Audio Distortion	Less than 2% @ 99% modulation
Modulation Monitoring	100% Peak Flasher Built-in envelope detector
Modulation Limiting	Built-in 100% peak modulation limiter 20 dB gain reduction: defeatable
Power Consumption	100 watts at 115 VAC
Size	W—15" H—9" D—6"
Weight	14 lbs.
Warranty	1 year — parts and labor

THE "PHASE II"

AM BROADCAST LINE

TR-20 TRANSMITTER

A solid state, variable power, 20 watt AM transmitter with internal audio limiter and detector circuitry.

CP-15 COUPLER

An antenna matching/line isolation unit with two stages and 15 values of impedance compensation, built-in reactance correction and bridge/metering circuit.

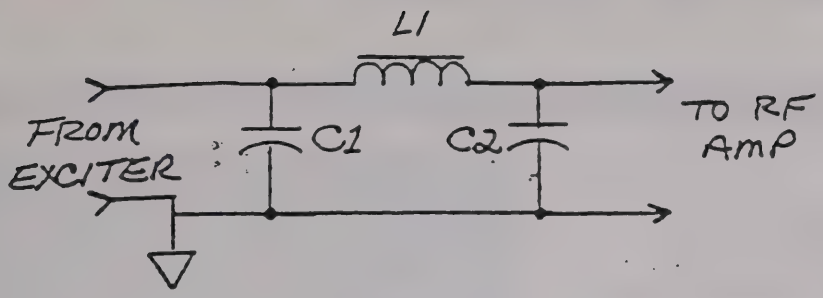
CP-10L COUPLER

An antenna matching unit design specifically for loop antennas with built-in reactance compensation.

SP SERIES SPLITTERS

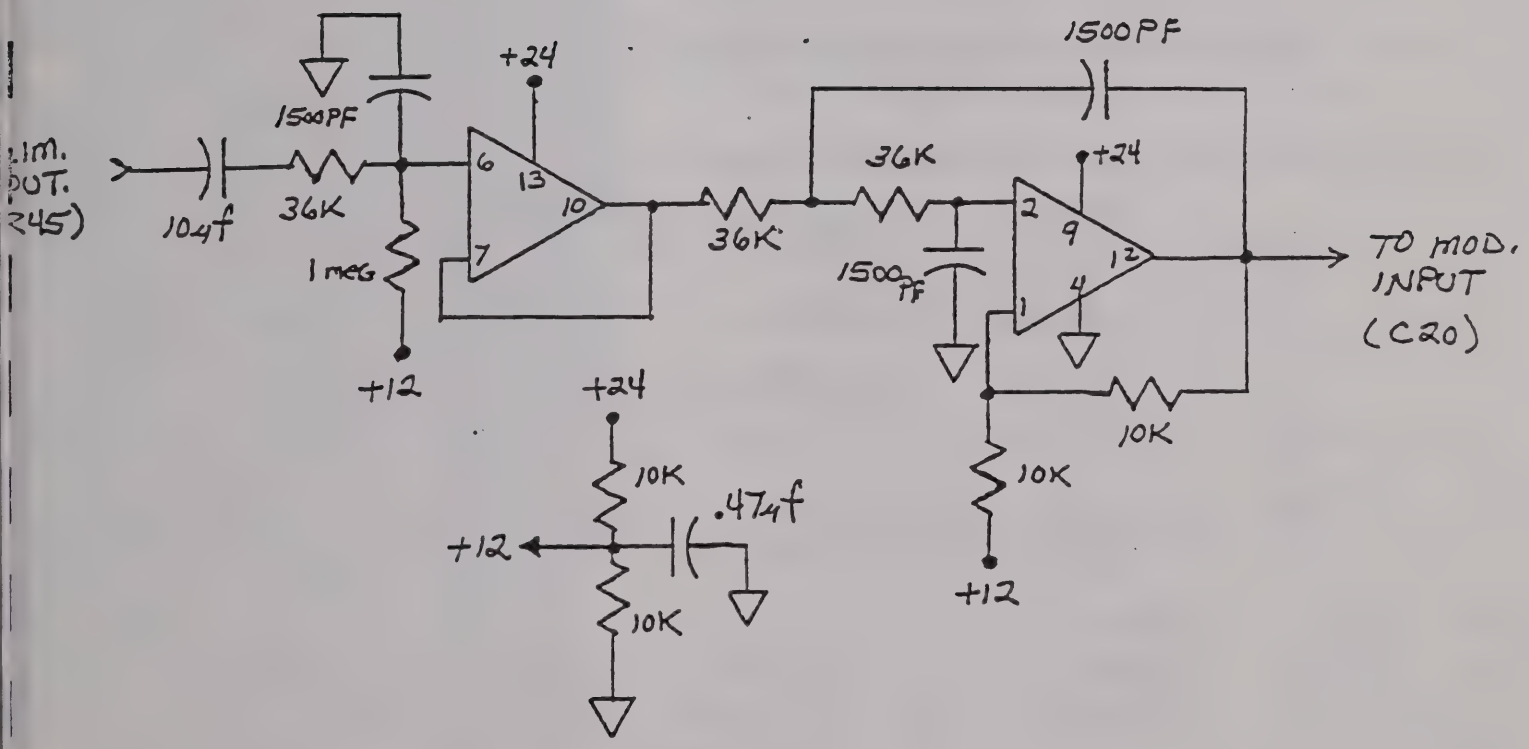
RF transformer type, low loss splitters, available in 2 to 8 output configurations.

RADIO SYSTEMS INC
DESIGN & MANUFACTURING



	530 KHZ	1610 KHZ
C1-C2	1500 PF	100 PF
L1	4T	2T

INTERSTAGE HARMONIC FILTER



3 KHZ AUDIO LOWPASS FILTER

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C. 20554

GRANT OF TYPE ACCEPTANCE

Radio Systems Design, Inc.
1400 Mill Creek Road
Gladwyne, PA 19035

Attention: Mr. Edward Corse

Re: Application dated February 27, 1980

Name of grantee Radio Systems Design, Inc.

Equipment Type Number TR-20T1S

Manufacturer Radio Systems Design, Inc.

Pursuant to the above referenced application, TYPE ACCEPTANCE of the equipment specified IS HEREBY ISSUED to the above-named GRANTEE for use under the Commission's Rules and Regulations as shown herein.

DATE OF GRANT: May 8, 1980

Note(s)	Rule(s) Part Number(s)	Frequency Range (MHz)	Input Watts	Output Watts	Frequency Tolerance	Emission
BB	90	.530-.530	-	20	100 Hz	6A3
BB	90	1.610-1.610	-	20	100 Hz	6A3

Remarks:

BB: Power output continuously variable from value listed to less than 0.5 watts.

C-3
sjf

FEDERAL COMMUNICATIONS COMMISSION

FCC Form 723A
October 1977

Cable Specification

Sheet 1 of 2

Part No. CBL 6169 REV. BASIC DATE 3/8/85

Description: Coaxial cable - lossy design - foam polyethylene dielectric - braid shield and drain wire PVC jacket

Construction:

Conductor: AWG .085" No. Str. solid Tin

Bare Copper Other

Insulation: Mt'l Foam Polyethylene Nom. Wall .081 O.D. .248" ± Nom.

Colors: ☐ Striped ☒ Solid ☐ Other -

Twisted Pair (s): N/A

Color Code: N/A

Other: -

Cable Layup: Conductor & dielectric with longitudinal 18 AWG 7/26 tin copper drain wire

Shield (s): ☒ Braid ☐ Spiral ☐ Tape ☐ Other

1) Braid ~~Spiral~~

AWG 30 Carriers 16 Ends 1

% Coverage 20% nominal

2) Tape

Mt'l Min. Lap % Coverage

Jacket: Mt'l PVC Nom. Wall .065 O.D. .446" ± nom.

Color Black Temp. 80°C Voltage -

Electrical Parameters:

Impedance Nominal 52.0 OHMS

Capacitance Nominal 26.0 PF/FT

Velocity Nominal 78 %

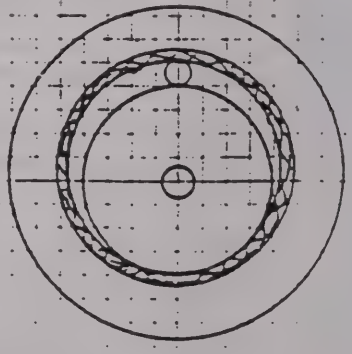
Attenuation DB/100 FT

Other Cable lengths shall be as specified.

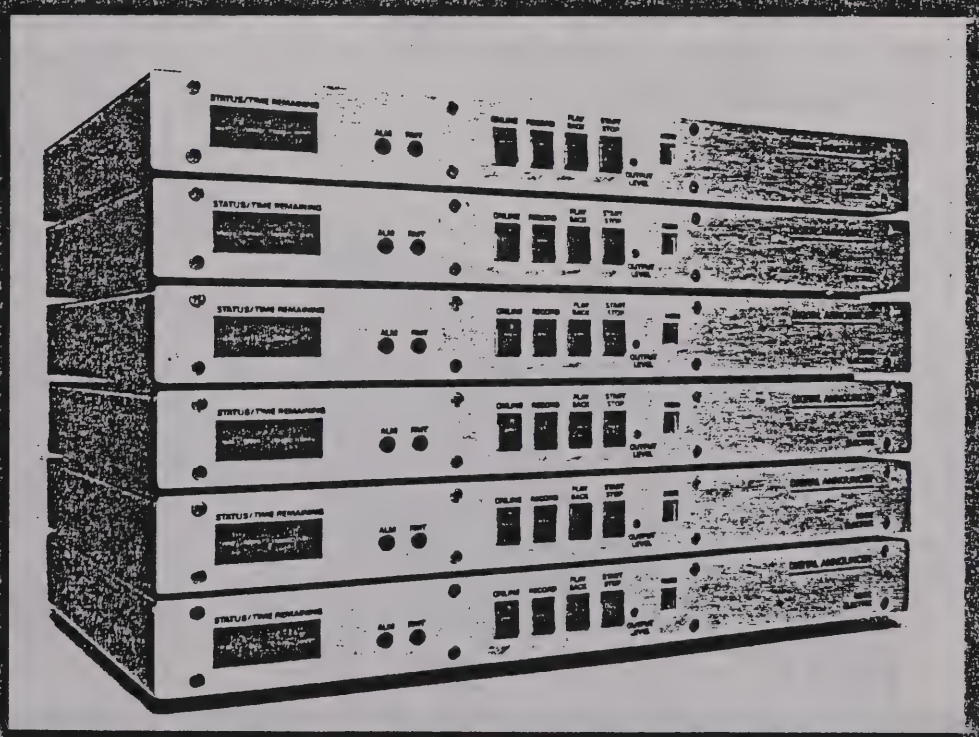
Notes:

Additional Notes:

Cable Cross Section:



Cook Electric Digital Announcers



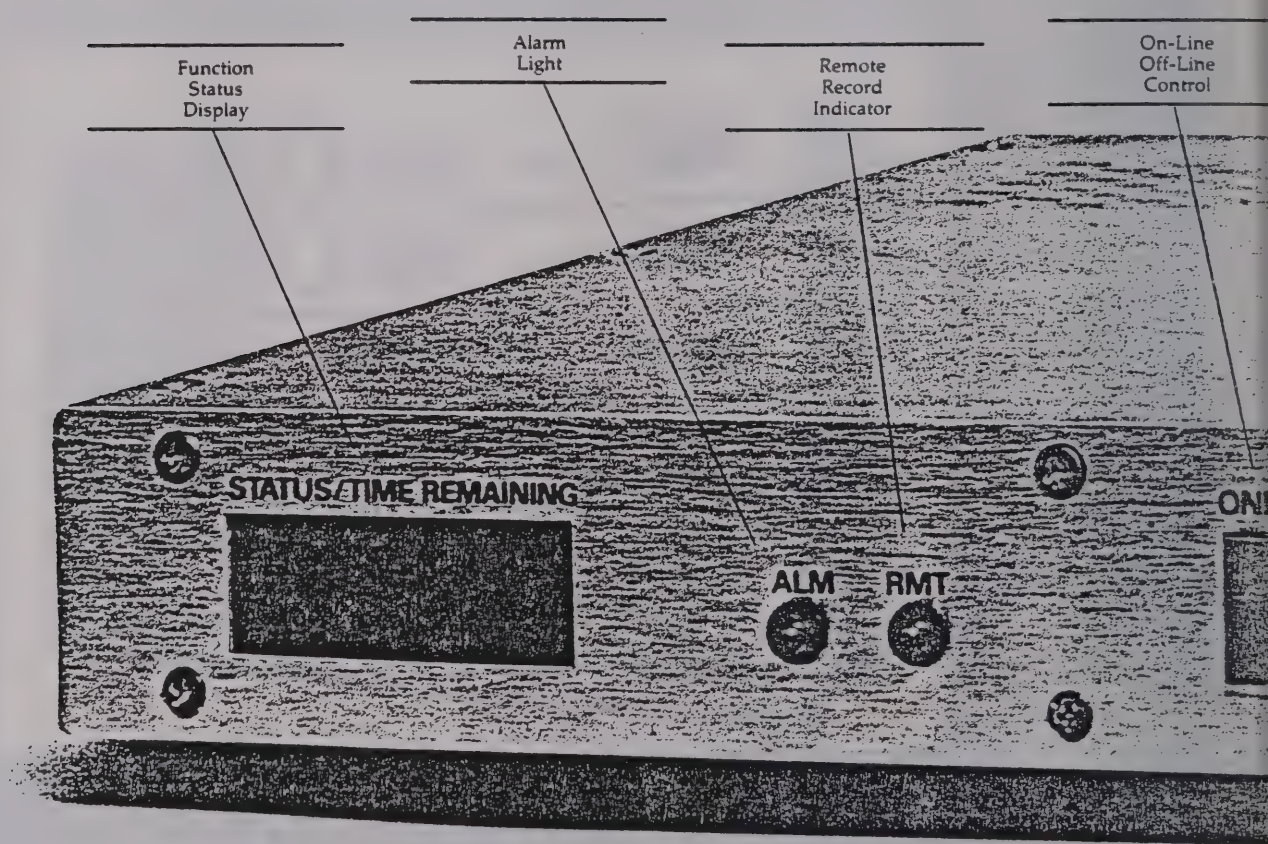
The Cook Electric Digital Announcer

speaks clearly and carries a small sticker price

Cook Electric's Digital Announcer offers an impressive array of benefits at a surprisingly affordable price. Because it's 100% solid-state, your messages are not stored on a drum or tape. They are recorded on silicon chips and generated electronically. Without cassettes to malfunction. Without tape heads to clean. Without motors to speed up or slow down. Without a single moving part. But, *with* a level of sound quality that won't degrade over thousands of uses.

The standard single-channel Digital Announcer with a 16-second message may meet your requirements exactly. But if it doesn't, you can add to the message length with 8-second message increments, for up to almost three minutes of recorded message. And, if you need more than one channel, you can use the single-channel unit as an "engine" to drive three more message channels, for a total of four.

The Digital Announcer is designed for either -48 VDC operation, or 110 VAC operation with the optional converter.



MONITORING AND RECORDING

The front panel of the Digital Announcer contains all the controls necessary for recording, monitoring and putting your recorded announcement in service. An illuminated four-digit display provides constant status reporting, with additional information supplied by panel and button-mounted LED's.

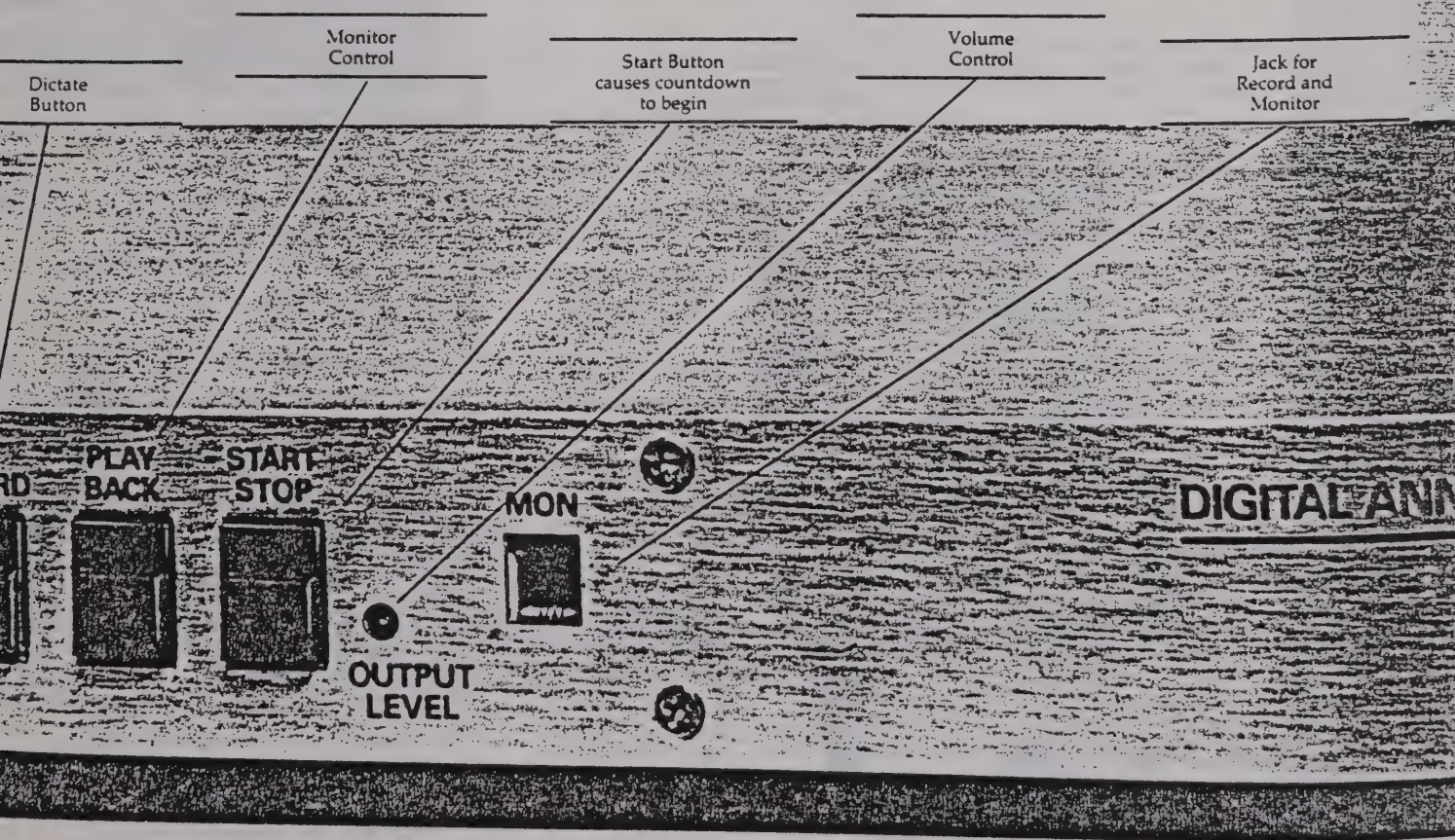
The rear panel provides user input-output via a wire-wrap edge connector, and dip switch selectable options such as sampling-frequency and SIT (Special Information Tones).

To record, either a telephone handset or a cassette recorder is plugged into the monitor jack provided. When the "RECORD" button is pushed, the display shows the recording time available. To initiate recording, press the "START/STOP" button; this also activates the timer countdown. To stop recording, press the "START/STOP" button again. The readout will display "SEL" (Select). Then, with a handset plugged in the monitor jack, press the "PLAYBACK" button to hear the recorded message. The readout will display the length of recording and count down to zero. Then, press the "ONLINE" button to put the announcer on line.

APPLICATIONS

Cook's Digital Announcer is ideal for high volume usage. It is compatible with electromechanical, electronic, or digital offices, and will operate with existing trunking equipment. Central office and PBX uses include:

- Weather reports, stock reports, movie programs and other public service announcements.
- Calling Card service announcements.
- Automated intercept system announcements.
- Telephone central office message generators.
- Automatic radio station identifiers.
- Messages to the public or staff at airports, universities, hospitals and other locations.
- Automated alarms for power companies, pipelines, refineries and other industries.



DIMENSIONS

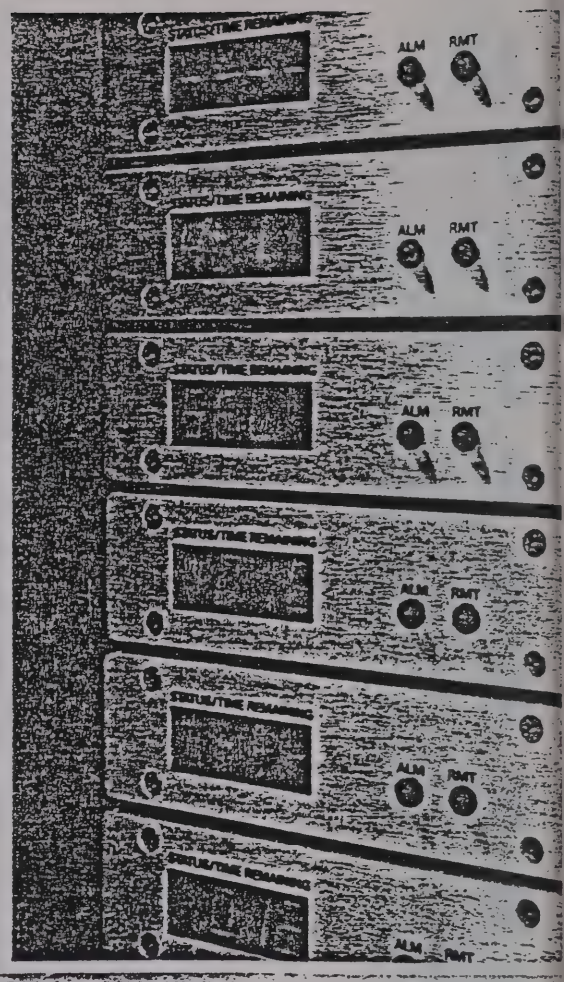
Standard Unit is 17.5" wide, 12" deep and 1.75" high.
Desk, tabletop or rack mounting with brackets available for mounting in 19", 23" and 26" racks. Weight of unit is approximately 5 lbs.

MESSAGE LENGTHS
(Standard Single-Channel Model)

- Frequency #1
  16.0 seconds maximum.
- Frequency #2
  21.4 seconds maximum.

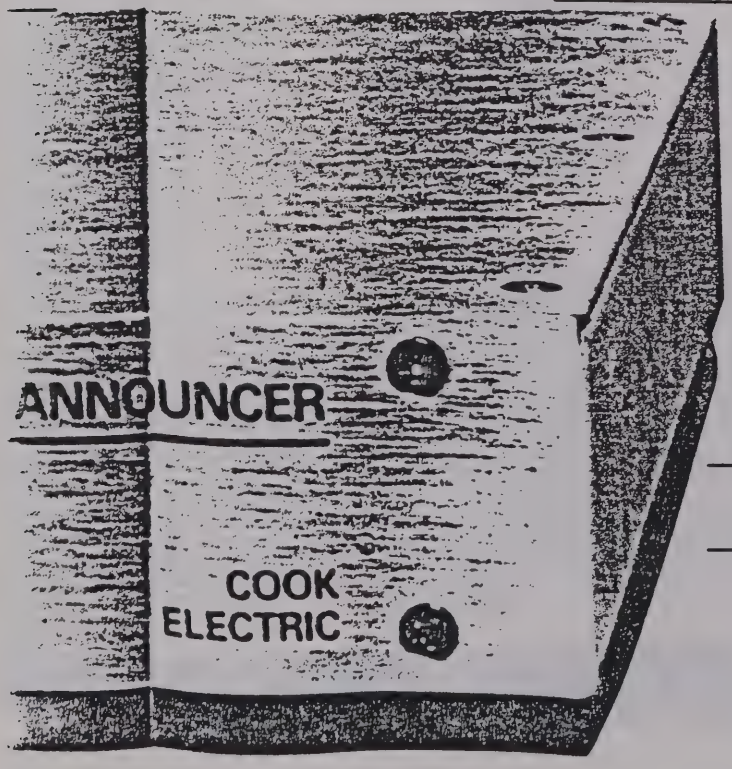
ELECTRICAL DESCRIPTION

- Operating Power
  -48 VDC or 110 VAC with optional converter.
- Input Power
  -42 VDC to -56 VDC @ 400 ma max. (internally fused @ 1A, MOV protected).
- S/N Ratio
  45 dbm, C message weighted.
- Distortion
  5% THD @ 0 dbm, 1 Khz sine wave.
- Tip/Ring Output
  4Ω Transformer isolated, MOV protected.
- Tip/Ring Output Loading
  Up to two hundred 900Ω trunks.
  OR up to one-hundred fifty 600Ω trunks.
- Beginning/Ending of Message Sync. Pulse
  Form C Relay contacts; 250 ms duration ±10 ms.
  4A max. load 30 Vdc resistive.
- Start Pulse
  +BATT or GND start, ≈ 16 ma; level sensitive.
- Unit Busy Output
  Form C Relay contacts.
  4A max. load 30 Vdc resistive.
- ALM Output
  Form C Relay contacts.
  4A max. load 30 Vdc resistive.



Optional Battery Charge and Battery Backup

Automatic SIT Tones comply with new requirements



Compact, fits one vertical rack space

Meets FCC EMI/RFI Requirements

VISUAL INDICATIONS

Four-Digit Display
- Select — SEL
- Unit in Use
- Time Remaining: Record and Playback modes, Record-Pause — 016
- Diagnostic Display
  - Power Alarm — AL-0
  - Memory Alarm — AL-1
  - Voice Alarm — AL-2
  - No Recording — AL-3
  - Internal Alarm — AL-4
- Peg Count (999,999 maximum) — 999999

LED Indicators
- Alarm (panel mounted) •
- Remote (panel mounted) •
- On-Line (switch mounted) •
- Record (switch mounted) •

NOTE: UNIT SHOWN ACTUAL SIZ

3 ways to bring Cook's Digital Announcer capabilities on board

1-Channel Announcer

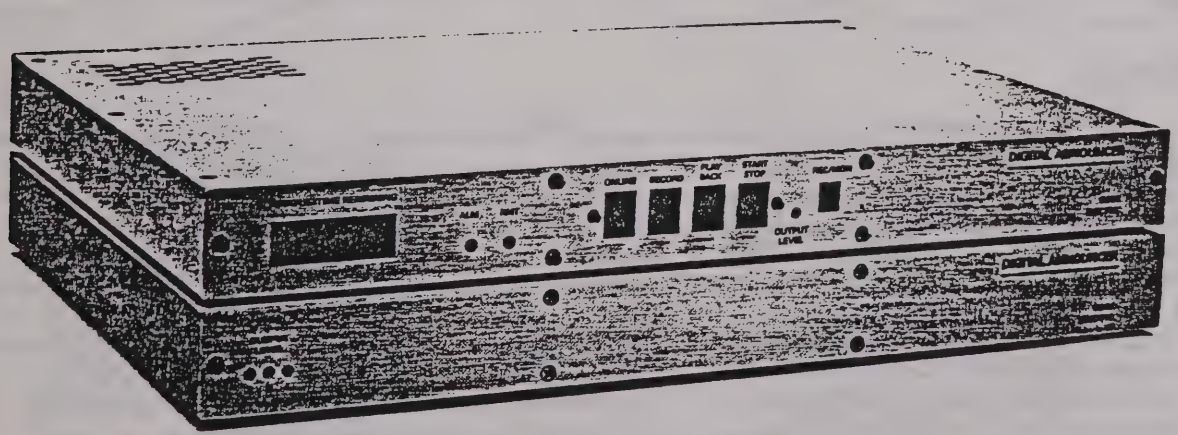
The Cook Single Channel Digital Announcer fits the needs of many users, requiring only 1½" of rack space to digitally store a message lasting up to three minutes.

3-Channel Adder Kit

As demand increases, you may find you will wish to add one, two or three additional channels. Then it's time to order Cook's 3-channel Adder Kit for easy field installation.

4-Channel Announcer

Or you can select the 4-channel Digital Announcer. This is the Single Channel Announcer plus the Adder Kit factory-assembled and tested.

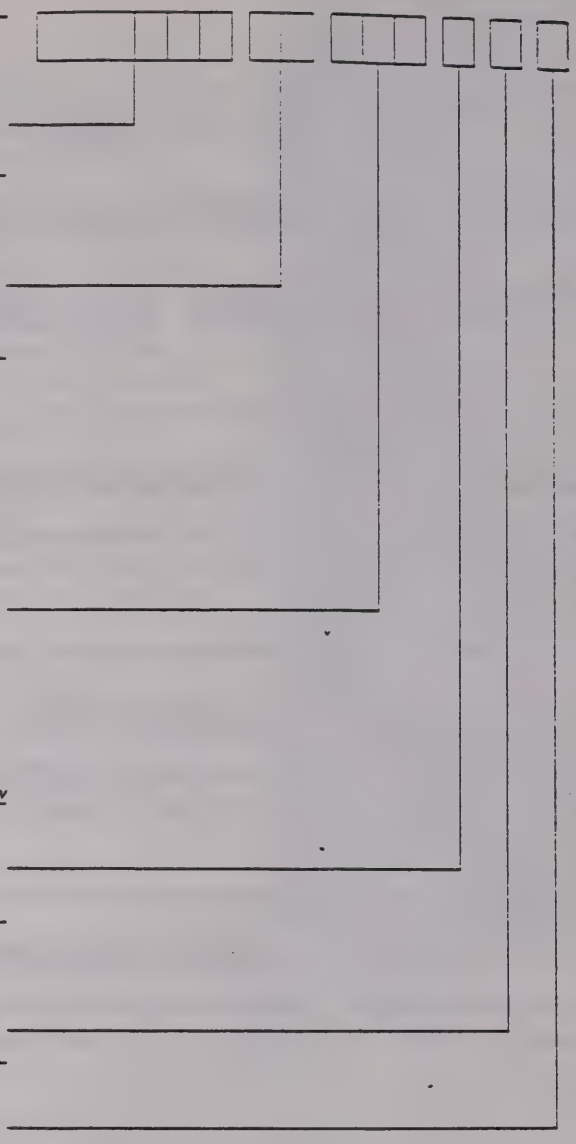


Optional Features Now Available:

- Remote Record Access
- Single Line Ring Trip (RJ-11 Connector)
- Four Line Ring Trip
- Four Port Phased Entry

ORDERING INFORMATION

Code Number	Type of Unit / Description
213300	Single-Channel Digital Announcer
213400	4-Channel Digital Announcer
213420	4-Channel Digital Announcer (4 synchronous channels)
213500	4-Port Demand Phased Entry D.A. (Single Message)
213550	4-Port Time Phased Entry D.A. (Single Message)



RELAY RACK MOUNTING BRACKET KITS

00 = None
19 = 19" Rack Bracket Kit
23 = 23" Rack Bracket Kit
26 = 26" Rack Bracket Kit
28 = 28" Rack Bracket Kit

NUMBER OF MESSAGE / SECONDS

008 =	*	8 seconds	
016 =		16 seconds	
024 =	*	24 seconds	
032 =		32 seconds	
040 =	*	40 seconds	
048 =		48 seconds	
056 =	*	56 seconds	
064 =		64 seconds	Includes
072 =	*	72 seconds	
080 =		80 seconds	Memory
088 =	*	88 seconds	
096 =		96 seconds	Adder
104 =	*	104 seconds	
112 =		112 seconds	Board
120 =	*	120 seconds	
128 =		128 seconds	

*Applies to single-channel units only

BATTERY BACK-UP

0 = None required
1 = Battery Back-Up

OPTIONS

0 = No option
1 = Remote record only
2 = Single ring-trip only
3 = Multi-ring trip & remote record
4 = Multi-ring trip only

CASE FACEPLATE FINISH

0 = Standard 1 = Custom 2 = NT Brown

How to Order:

First, select the type of unit desired and write its number. Then select the features required and write their numbers in the sequence indicated by the matrix.

EXAMPLES:

1. Single-Channel Digital Announcer E/W 19" rack bracket kit, 16 second message length and no battery back-up or remote options
   213300-19 016 0 0 0
2. Single-Channel Digital Announcer E/W 23" rack bracket kit, 32 second message length battery back-up and remote record options
   213300-23 032 1 1 0

ACCESSORIES

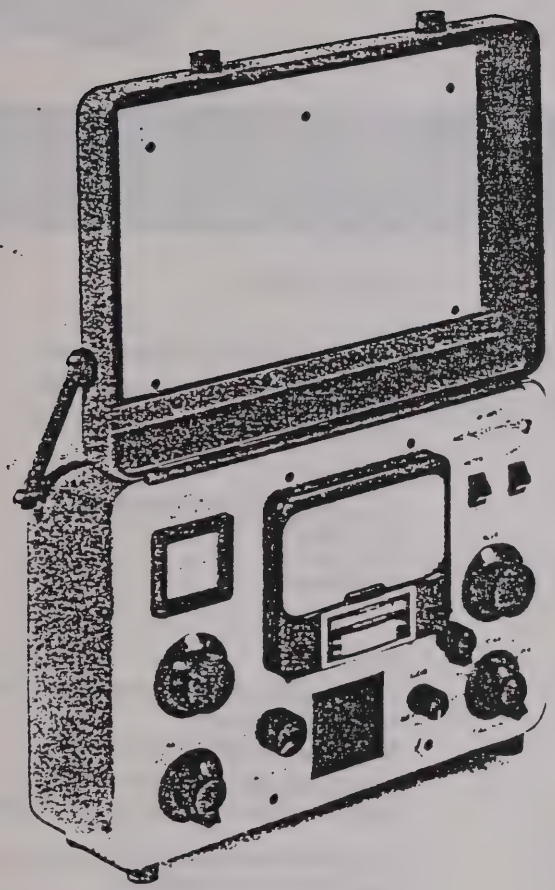
Ordering Number	Description
	The following hardware allows conversion of a single channel Digital Announcer to a 4 port or 4 channel announcer (requires new program firmware — listed below.)
213289-101	3 Channel/Port Hardware Adder Kit — No Brackets
213289-119	3 Channel/Port Hardware Adder Kit E/W 19" Brackets
213289-123	3 Channel/Port Hardware Adder Kit E/W 23" Brackets
213289-126	3 Channel/Port Hardware Adder Kit E/W 26" Brackets
213289-128	3 Channel/Port Hardware Adder Kit E/W 28" Brackets
213405-001	Single Channel Program Firmware
213405-005	4 Channel Program Firmware
213405-006	4 Channel Program Firmware (synchronous)
213405-009	4 Port Demand Phased Entry Program Firmware
213405-011	4 Port Time Phased Entry Program Firmware
215000-101	Test & Distribution Interface for DMS-10 (4 Ch)
215000-103	Test & Distribution Interface for DMS-10 (8 Ch)
215000-105	Test & Distribution Interface for DMS-10 (12 Ch)
	Item below is included in 215000-Series Interface
215001-101	Test & Distribution Chassis Only for DMS-10 (4 Ch)
215001-103	Test & Distribution Chassis Only for DMS-10 (8 Ch)
215001-105	Test & Distribution Chassis Only for DMS-10 (12 Ch)
	Item below is included in 215000-Series Interface
215050	Connector Plate Assembly & Cables from Test & Distribution Box to DMS-10 up to 12 Ch.
	Item below is included in 215000-Series Interface
215056	Mounting Rack for DMS-10 (26") Hold up to 12 Ch. of Announcers and Test & Distribution Chassis

Ordering Number	Description
	Item below is included in 215000-Series Interface
215064	Interconnect Cable Harness from Test & Distribution Chassis to Announcers (4 Ch)
215065	Interconnect Cable Harness from Test & Distribution Chassis to Announcers (8 Ch)
215040	Interconnect Cable Harness from Test & Distribution Chassis to Announcers (12 Ch)
	Item below is included in 215001-Series Interface
215038	4 Channel Pulse Alarm & Disconnect Assembly
213388	Single Line Ring Trip Access Circuit Adder Kit
213385	4 Line Ring Trip Access Circuit Adder Kit
213404	Cassette Recording of Standard Telephone Office & PBX Announcements
213287-101	Remote Record Kit
213284	Cassette Adapter Cord
213360	Handset with Cassette Jack and Cassette Cord
213286	Additional Recording Time Kit (8-seconds)
213285	Handset
213288	A/C Converter, Single-Channel (2 req'd for multi or P.E.)
213323	Memory Adder Board without Memory
680-7895	Rechargeable Batteries for battery backup (Set of 4)
213281-101	19" Bracket Kit
213281-103	23" Bracket Kit
213281-105	26" Bracket Kit
213281-113	28" Bracket Kit

NORTHERN TELECOM INC.
6201 OAKTON STREET
MORTON GROVE, IL 60053

Tele: 312-967-6600

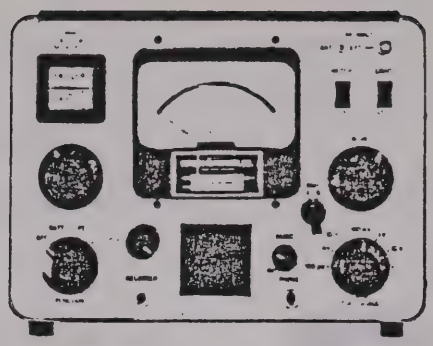
FIELD STRENGTH METERS



- 6 POSITION (20 dB PER STEP) ATTENUATOR
- HIGH Q DOUBLE-TUNED RF INPUT FOR MAXIMUM IMAGE REJECTION
- MULTI-POLE HYBRID I.F. FILTER WITH SHAPE FACTOR (6 dB TO 60 dB) OF 2.2:1
- FULLY TEMPERATURE COMPENSATED CIRCUITRY PLUS VOLTAGE REGULATION FOR LONG TERM STABILITY
- FOUR-INCH, MIRRORED SCALE, TAUT-BAND METER WITH INTERNAL LIGHTING
- FRONT PANEL SPEAKER WITH WEATHER-TREATED CONE OR HEADPHONE OUTPUT
- RF COAXIAL INPUT FOR MEASURING TERMINAL VOLTAGE BETWEEN 10 uV AND 10 V
- MECHANICAL "VERNIER" IS INTEGRAL PART OF RECEIVER TUNING CONTROL
- DIFFERENTIAL COMPARISON CIRCUIT FOR BALANCING OSCILLATOR AND RECEIVER OUTPUT FOR PRECISE CALIBRATION
- CAPABLE OF SIGNAL RATIO MEASUREMENTS (INCLUDING HARMONICS) TO −80 dB

The Models FIM-21, FIM-22, and FIM-41 represent a new generation of precision instruments for direct measurement of electromagnetic fields in the 200 kHz to 5.0 MHz frequency spectrum. These units are intended for portable field use and include a laboratory quality receiver, integral shielded loop antenna, precision attenuator, internal calibration source, and voltage regulated battery power supply. With calibration accuracy traceable to the National Bureau of Standards, these instruments are capable of meeting the most exacting requirements of government and industry. Cases are of ruggedized drawn aluminum with a hinged cover containing the loop antenna. With the cover in the vertical position, the antenna terminals are connected to the receiver by maintenance-free gold-plated contacts. An interlock switch prevents inadvertent battery discharge when the cover is closed.

A simplified calibration procedure assures measurement accuracy. Frequency is easily resolved on an illuminated expanded dial with large numerals. When the receiver is tuned, the calibrating oscillator is simultaneously tuned to within a few kHz of the selected frequency with vernier tuning provided by a separate control. Proper gain calibration is precisely indicated by a sharp null on the meter when the ten turn gain control is adjusted for an exact balance between the detected outputs of the receiver and calibrating oscillator. Field strength is displayed by the front panel meter on a logarithmic scale calibrated in increments from 1 to 10. Full scale meter sensitivity is determined by the attenuator range switch. Signal ratio (i.e., harmonic) measurements are easily resolved using the dB scale of the meter in conjunction with the 20 dB per step range switch. A DC analog voltage proportional to meter deflection is provided for recording purposes.



SPECIFICATIONS — FIM-21

FREQUENCY RANGE	535 kHz to 1605 kHz
FIELD INTENSITY RANGE	10 microvolts per meter to 10 volts per meter
ACCURACY OF CALIBRATION	1 Percent, referenced to NBS Standard Field*
ACCURACY OF RANGE ATTENUATOR	2 Percent over entire FI range and tuning band
SELECTIVITY	
Bandwidth (6 dB)	7 kHz nominal with multi-pole hybrid filter
Bandwidth (60 dB)	15 kHz nominal
IF Rejection	35 dB minimum
Image Rejection	65 dB minimum
IF FREQUENCY	455 kHz
PANEL METER	4" mirrored scale, logarithmic graduations 1 to 10, taut band meter movement, 3% linearity
ANTENNA	Shielded loop, integral part of hinged cover
AUDIO OUTPUTS	Front panel loudspeaker, weather treated cone Headphone jack, high and low Z (disconnects speaker)
RECORDER OUTPUT	0.4 to 4 volts DC proportional to field intensity for each attenuator range, source resistance 2200 ohms
LIGHTS	Frequency dial and meter; panel switch for night use
BATTERIES (6 Required)	Standard 1½ volt C-Z_n "D" cells or 1½ volt Alkaline cells for extended life at very low temperatures
BATTERY LIFE	Greater than 1000 FI readings (reduced life with frequent use of lights and/or high speaker volume)
ENVIRONMENTAL	Continuous exposure -10^0F to $+130^0$F; lower temperature operation practical for "reading time" exposures
DIMENSIONS	8¾ in. high, 11½ in. wide, 5-1/8 in. deep with cover closed; 3-7/8 in. deep with cover open (gripping width)
WEIGHT	Approximately 11½ pounds (includes batteries)
EXTERNAL RF INPUT	535 kHz to 1605 kHz, 10 microvolts to 10 volts
RF INPUT SWITCH	Selects loop antenna (ANT) or panel connector (EXT)
METER SWITCH	Selects normal linear (LIN) or logarithmic (LOG) operation
LOGARITHMIC DYNAMIC RANGE	60 dB compressed input range for FI meter and recorder input

*Calibrated at 220 millivolts per meter

APPENDIX II

MEMORANDA CONCERNING SYSTEM MALFUNCTION, REPAIR, AND MAINTENANCE

Form AD-40 5/77 NEW JERSEY DEPARTMENT OF TRANSPORTATION

MEMORANDUM

TO Thomas Norris, Resident Engineer

FROM Mark Marsella, Bureau of Transportation Technology Research

SUBJECT I-80, Sections 1AL, 6G, 7H Problems with HAR DATE 10/31/85 TELEPHONE NO.

Attached is a chronological list of the numerous problems we have had with the HAR system. The period covered is from the first day of operation on 5/9/85 through 10/9/85. Supplemental information will follow.

In general, the system has been only marginal in its reliability and the quality of its output signal. Some of the problems (e.g., extensive delays in performing repairs; failure to mark splices so that they could be found later; lack of in-house communication) are immediately traceable to the contractor(s). Problems having to do with equipment malfunction are somewhat less so but certainly no less the contractor's responsibility, since he is required to provide us with a reliable system. I feel that up to now this has not been done; every major component of the system (cooling fans, transmitters, recorder, antenna) has failed at least once and some as many as four times. Furthermore, the contractor's diagnosis of malfunctions and his corrective measures have not always eliminated the particular problem(s). Taken as a whole, these factors have greatly prolonged data collection and have increased research costs, which should be taken into account in deciding future payment for the system.

Although no data collection is scheduled after 11/15, I believe it would be well to leave the system in place and operational until next spring. This would allow us to monitor it periodically and to make a better overall assessment of its reliability.

Mark Marsella
Principal Engineer

Attachments
cc: E. F. Reilly
T. Fuca

5/9/85 - First day of operation. One cooling fan not operating; contractor aware of problem.

5/15/85 - Field strength readings taken at various locations on both legs show that the east leg is well above the limit allowed by the FCC. The contractor was informed of this on 5/16 or 5/17.

5/20/85 - Further field strength readings taken. East leg still above FCC limit.

5/22/85 - Contractor (Radio Systems) borrowed field strength meter to take readings to assist in adjusting transmitter to meet FCC requirements.

5/30/85 - First day of data collection; fan still not working and not replaced. Test message recorded at end of day and put on line for monitoring.

6/6/85 - Power failure some time between 5/30 PM and 6/6 AM. Recorder did not retain test message. Contractor Cruz was aware of problem but did not notify me or Radio Systems, as far as I know. Recorder retained message during data collection and test message which was recorded at end of day.

6/13/85 - Recorder lost message again between 6/6 PM and 6/13 AM. Battery backup switch on at recorder, but there was no backup power. Incoming AC power was all right, and the recorder held the message for the remainder of the day and the test message recorded at the end of the day after data collection.

6/18/85 - The test message was lost again, sometime after 6/13 PM. No repairs were made since trouble began, which was before 6/6. I called Radio Systems from Netcong, and Mr. Braverman assured me recorder would be repaired or replaced the next day, 6/19.

6/19/85 - Replacement or repair accomplished prior to my arrival on site. Operated correctly all day. I left a test message on the recorder, with the transmitters off, at the end of the day at the contractor's (Lightning) request.

6/20/85 - Test message retained from yesterday. Recorder and transmitters operated correctly all day. Left test message as was done previous day.

6/25/85 - Neither cooling fan operating; necessary to keep door open all day during data collection to prevent overheating. Test message recorded at end of day but not put on line, to keep transmitters from overheating.

6/26/85 - New cooling fans were installed during the day while data collection was in progress. One fan had not been operating since installation on 5/9.

6/27/85 - Recorder again losing message when power goes off. Recorder, transmitters, and fans all operating correctly at the end of the day when test message was recorded and put on line.

7/2/85 - No test message being broadcast when I arrived at site; apparently lost again because of power failure. Recorder operated correctly all day and when test message was recorded and put on line at end of day.

7/9/85 - Test message not audible for more than 100 yards from transmitter on east leg; faded completely in two places on west leg. I recorded message for data collection. Recorder held message but quality of output was as described for test message. I informed contractor (Radio Systems; Andy) of above at end of day. He did not give me a date for repair, nor did he have any information on availability of a replacement recorder.

7/10/85 - Problems as on previous day.

7/12/85 - I called Andy at Radio Systems and arranged for repairs to antenna on 7/16.

7/16/85 - Contractor (Radio Systems) replaced recorder and repaired splice on west leg of antenna. No improvement in dead and weak spots. Recorded test message and put on line at end of day.

7/18/85 - Test message still being broadcast; weak and dead spots as before.

7/22/85 - Talked to Braverman at Radio Systems about repairing antenna.

7/23/85 - Braverman informed me that repair cannot be made until early next week because of lack of personnel.

7/30/85 - Transmision better than on 7/18, apparently because ground is much drier. Radio systems personnel and Kevin Flynn of Lightning on site. East leg splice in antenna not marked by Radio Systems when made, so it took over an hour to find it. There was no apparent problems with the splice and Radio Systems personnel could not determine cause of problem (which appeared to me to be antenna damage, judging from the tire tracks on a portion of the east leg antenna trench). No repairs were made to system, but Andy took field strength reading every 100 yards along the east leg, to be analyzed later.

7/31/85 - Radio Systems analyzing readings from previous day and fabricating splice boxes for use on antenna. Could not give me date for repairs.

8/2/85 - Both legs of antenna repaired and system functioning properly. One fan not operating again. I informed Radio Systems personnel on job, who were supposed to arrange for replacement. I recorded test message and put on line at end of day.

8/22/85 - Test message not on line when I arrived on site. Recorded new message and tested; message not retained if AC power cut off. One fan still not working (from 8/2). I called Braverman at Radio Systems who said he had not heard that one fan was not working (since 8/2!). He said he would send a replacement fan and recorder to Kevin Flynn to replace existing units.

8/23/85 - Informed Braverman that upon looking over his specifications it appears that Radio Systems has been installing the wrong cooling fans. The one they specified for the installation has a working temperature of 77° F, which was generally much below the temperature in the transmitter cabinet. Braverman said he would investigate and if necessary order new fans and have them installed.

8/29/85 - Spoke to Ron Lesser(?) at Lightning in PM, who said they had just received the replacement fan and recorder from Radio Systems (which were supposedly shipped UPS on 8/22). He will see that they are installed by Tuesday 9/3, in time for data collection.

9/4/85 - Called Lightning to verify replacement of units. Kevin Flynn said that items were not replaced, since he assumed that they were for stock (despite my conversation with Ron on 8/29). He will have units installed tomorrow , prior to 10 AM.

9/5/85 - Recorder and fan (77° model) replaced in time for data collection. East leg of antenna normal; west leg almost completely dead. Reversing connections showed that transmitter, not antenna, was at fault. I notified Braverman at Radio Systems of this in the PM, and also that both fans were working but were the ones rated for 77°.

9/6/85 - Braverman from Radio System informed me that the correct cooling fans have been ordered. (I originally told him about the fans on 8/23.)

9/9/85 - Ron Lesser(?) from Lightning informed me that malfunctioning transmitter will be replaced tomorrow.

9/19/85 - Transmitter apparently replaced sometime between 9/9 and 9/19. Output from east leg of antenna better but still very weak in spots, with considerable static, but nevertheless acceptable. The recorder retained the message from 9/5. The correct fans were still not installed.

9/26/85 - East leg of antenna dead for about 200 yards in one location and very weak in two others, with considerable static overall; west leg good. Reversing antenna leads showed that transmitter was bad, rather than antenna. I informed Braverman of above; he will call Lightning.

10/1/85 - Ron Lesser from Lightning called: The transmitter was never replaced subsequent to problems on 9/5. I assume that the drier weather and ground allowed the transmitter to produce a poor but acceptable signal on 9/19, but dampness on 9/26 caused it to deteriorate again. Kevin Flynn called me to find out which leg had the bad transmitter, since (he said) this could not be determined by listening to the message. He will have the unit replaced tommorrow AM and call me to verify.

10/8/85 - East leg good; west leg had two very weak locations of 100+ yards each. Other locations on west leg good, even though ground was damp. Recorder retaining message from 10/1.

10/9/85 - Operation as on previous day; message retained from yesterday.

Form AD-40 5/77 NEW JERSEY DEPARTMENT OF TRANSPORTATION

MEMORANDUM

TO John Carulli

Resident Engineer

I-80, Sections 1AL, 6G, 7H

FROM Mark Marsella

Division of Research

SUBJECT Problems with HAR DATE 9/19/86 TELEPHONE NO. 5-2992

Attached is a second chronological list of the problems we have had with the HAR system. It covers the period from 10/10/85 through 6/10/86. Our driver interviews and TV tapings were completed on 11/4/85, but we continued to monitor the system throught 6/10/86, when the last set of field strength readings were taken.

In my opinion the output signal from the system was marginal at best. During wet or damp periods static and distortion often developed, sometimes to a degree where the intelligibility of the message was substantially reduced. As for reliability, I feel that the system was unsatisfactory, both as a whole and in its individual components. To repeat my statement of 10/31/85, every major component has failed at least once and some as many as four times.

Troubleshooting and repair were also unsatisfactory. There were unnecessary and often prolonged delays in both areas, sometimes rendering the system unuseable in part or in whole for up to three weeks. This caused the data collection phase of our project to run four to six weeks over schedule.

In addition, there were at least two instances during the last two weeks of data collection when the contractor (Cruz) failed to uncover the HAR warning signs. This caused us to lose valuable data with no hope of recovering it at a later date. To add to the difficulties, it appears that the contractor did not make any consistent effort to monitor the system in order to correct problems (see Supplementary Specifications, page 88, first full paragraph). I repeatedly advised Bob Zglobicki of Cruz that compliance with this requirement was expected and that he should maintain a log accordingly. Although Tom Norris has requested whatever records were kept, he had not received anything as of Friday, 9/12/86.

In view of the numerous problems with the system and its unsatisfactory performance, the unsatisfactory troubleshooting and repair history of the contractor, and the contractor's failure to produce any records since HAR operations terminated three months ago, I recommend that no further payment be made for this item.

Mark Marsella
Project Engineer

Att.
MM:jf
cc: T. Fuca

10/28/85 - Weak spots on west leg as on 10/8 and 10/9.

10/31/85 - Problems with west leg as before. Cruz failed to uncover signs, despite two notifications in AM to do so. I did not learn that signs were not uncovered until about 2:30, so that data collected for the day could not be used.

11/1/85 - I informed D. Braverman of Radio Systems that problems dating from 10/8 had still not been corrected. He said he would investigate.

11/7/85 - Cooling fans not operating. Weak and dead spots as before on west leg of antenna; portions having discernable message producing distorted signal with considerable static.

11/14/85 - Cruz failed to uncover signs and provide arrow boards for AM data collection; I had to reschedule for PM. Problems with antenna as previously.

1/17/86 - Informed by Tom Norris that there was no signal on either leg of the antenna. I informed D. Braverman who told me to contact Lightning since he had fulfilled his part of the contract, had been paid, and had no further responsibility for maintaining the system. I informed Ron Lesser of problem and told him that we would like to have repairs completed by 1/23 in order to take field strength readings. He said he would keep me informed of repairs and progress.

1/22/86 - I called Lesser since I had received no word from him. He told me that he had recorded a new message on 1/20 which was still being retained and broacast late in the afternoon on that date. He had been unable to find the reason for the problem of 1/17.

1/24/86 - West leg of the antenna dead or almost dead along much of its length.

3/26/86 - Field strength readings taken; weak and dead spots along much of west leg of antenna.

6/10/86 - Field strength readings taken; weak and dead spots along most of both legs of antenna.

APPENDIX III

TRAFFIC COUNTS AND SPEEDS

LIST OF ABBREVIATIONS

OBS: NUMBER OF USABLE OBSERVATIONS TO THIS POINT.

FC: NUMBER OF LIGHT VEHICLES IN FAST LANE.

FT: NUMBER OF TRUCKS IN FAST LANE.

MC: NUMBER OF LIGHT VEHICLES IN MIDDLE LANE.

MT: NUMBER OF TRUCKS IN MIDDLE LANE.

SC: NUMBER OF LIGHT VEHICLES IN SLOW LANE.

ST: NUMBER OF TRUCKS IN SLOW LANE.

SPC: AVERAGE SPEED OF LIGHT VEHICLES, DETERMINED BY AVERAGING SPEEDS OF 10 - 15 VEHICLES IN FAST AND MIDDLE LANES.

SPT: AVERAGE SPEED OF TRUCKS, DETERMINED BYAVERAGING SPEEDS OF 10 -15 VEHICLES IN MIDDLE AND SLOW LANES.

( ): NUMBER OF LIGHT VEHICLES WITH HEADLIGHTS ON; CAMERA LOCATION 2 ONLY.

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR OFF - CAMERA LOCATION 1

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	06/06/85	11:30-12:30	154	0	475	116	203	133	59.2	54.9
2	06/18/85	14:00-15:00	217	1	582	119	242	135	57.4	54.2
3	06/19/85	11:00-12:00	164	1	516	127	222	148	57.2	52.1
4	06/19/85	13:00-14:00	200	1	560	130	224	144	59.0	53.0
5	06/19/85	14:00-15:00	216	2	559	150	221	143	57.9	53.4
6	06/27/85	13:30-14:30	114	2	324	70	136	74	59.9	55.5
7	07/02/85	11:00-12:00	200	4	544	95	265	126	60.5	56.3
8	07/02/85	13:00-14:00	230	2	550	123	274	131	58.2	54.6
9	07/02/85	14:00-15:00	214	1	546	120	270	130	58.2	54.4
10	08/29/85	13:00-14:00	261	1	628	143	305	157	59.1	55.6
11	08/29/85	14:00-15:00	343	0	756	129	336	151	59.3	55.4
12	10/31/85	11:00-12:00	87	1	435	109	218	179	57.6	56.1
13	10/31/85	13:00-14:00	150	2	469	116	217	177	59.0	55.2
14	11/14/85	10:00-11:00	65	1	360	111	172	158	59.7	53.4

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR ON 1 - CAMERA LOCATION 1

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	05/30/85	13:00-14:00	157	4	480	111	191	172	57.2	53.3
2	05/30/85	14:00-15:00	207	1	575	107	236	151	57.6	51.9
3	06/06/85	13:00-14:00	229	4	564	150	229	133	58.6	56.9
4	06/06/85	14:00-15:00	230	0	566	140	230	135	58.6	56.8
5	06/13/85	11:00-12:00	183	1	536	106	227	138	60.1	54.0
6	06/13/85	13:00-14:00	180	1	454	113	193	122	56.0	54.3
7	06/13/85	14:00-15:00	230	1	574	130	235	156	55.9	54.2
8	06/25/85	11:00-12:00	185	2	505	132	155	114	59.9	56.2
9	06/25/85	13:00-14:00	240	3	550	145	199	117	59.3	54.4
10	06/25/85	14:00-15:00	244	2	558	155	190	119	59.2	54.0
11	06/26/85	11:00-12:00	207	3	584	144	232	128	59.2	53.2
12	06/26/85	13:00-14:00	221	1	570	130	225	130	58.2	54.7
13	06/26/85	14:00-15:00	230	1	575	133	220	102	58.2	54.0
14	06/27/85	11:00-12:00	193	6	591	121	203	125	57.9	55.7
15	06/27/85	13:00-14:00	115	3	323	71	135	75	59.9	55.5
16	06/27/85	14:00-15:00	115	2	324	71	138	76	59.6	55.3

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR ON 2 - CAMERA LOCATION 1

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	07/09/85	13:00-14:00	216	1	550	119	226	135	58.6	55.2
2	07/11/85	11:00-12:00	192	3	579	136	232	120	59.7	55.6
3	07/11/85	13:00-14:00	233	2	511	129	229	109	59.8	54.5
4	09/05/85	11:00-12:00	168	1	475	110	187	165	59.8	54.0
5	09/05/85	13:00-14:00	240	5	649	167	303	196	58.8	55.6
6	09/05/85	14:00-15:00	170	3	480	115	200	140	58.7	55.5
7	09/19/85	11:00-12:00	165	1	467	124	258	175	60.0	54.3
8	09/19/85	13:00-14:00	172	1	510	119	250	151	60.6	54.6
9	09/26/85	11:00-12:00	116	0	458	143	216	176	59.6	55.8
10	09/26/85	13:00-14:00	130	0	474	114	246	164	58.6	55.4

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR ON 2L - CAMERA LOCATION 1

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	10/30/85	11:00-12:00	84	1	449	178	228	172	58.4	53.7
2	10/30/85	13:00-14:00	152	1	550	108	231	184	60.0	56.8
3	10/30/85	14:00-15:00	150	1	539	101	230	180	59.0	56.7
4	11/07/85	11:00-12:00	101	0	526	125	243	194	58.2	55.6
5	11/07/85	13:00-14:00	139	1	563	118	278	182	58.1	57.3
6	11/07/85	14:00-15:00	202	2	632	149	283	161	57.2	54.9
7	11/14/85	13:00-14:00	121	1	446	139	204	179	59.9	53.4

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR OFF - CAMERA LOCATION 2

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	06/06/85	11:00-12:00	0	0	777(3)	106	535(2)	255	53.3	40.6
2	06/18/85	14:00-15:00	0	0	426(2)	48	422(2)	139	51.3	43.6
3	06/19/85	11:00-12:00	0	0	505(0)	75	460(1)	212	50.1	42.6
4	06/19/85	13:00-14:00	0	0	562(2)	80	500(1)	220	47.9	45.0
5	06/19/85	14:00-15:00	0	0	545(1)	85	541(1)	229	47.8	45.0
6	06/27/85	13:00-14:00	0	0	318(1)	46	316(1)	108	49.0	40.2
7	07/02/85	11:00-12:00	0	0	596(0)	76	518(0)	188	50.6	38.2
8	07/02/85	13:00-14:00	0	0	556(2)	75	576(1)	190	52.4	43.2
9	07/02/85	14:00-15:00	0	0	555(1)	74	570(1)	189	52.4	43.0
10	08/29/85	13:00-14:00	0	0	675(1)	101	624(1)	207	49.5	43.4
11	08/29/85	14:00-15:00	0	0	592(0)	66	564(1)	163	48.0	42.3
12	10/31/85	11:00-12:00	0	0	414(1)	76	433(0)	211	48.3	43.7
13	10/31/85	13:00-14:00	0	0	459(0)	78	441(0)	223	48.1	40.7

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR ON 1 - CAMERA LOCATION 2

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	05/30/85	13:00-14:00	0	0	471(3)	87	432(5)	185	48.5	43.2
2	05/30/85	14:00-15:00	0	0	649(3)	92	573(2)	208	48.1	43.3
3	06/06/85	13:00-14:00	0	0	510(3)	100	501(2)	160	50.0	40.9
4	06/06/85	14:00-15:00	0	0	590(2)	110	526(2)	191	49.9	40.8
5	06/13/85	11:00-12:00	0	0	484(1)	57	431(3)	173	48.8	38.9
6	06/13/85	13:00-14:00	0	0	503(2)	96	472(1)	203	49.1	42.2
7	06/13/85	14:00-15;00	0	0	518(3)	70	482(2)	204	53.2	41.1
8	06/25/85	11:00-12:00	0	0	610(0)	92	515(0)	202	49.1	44.6
9	06/25/85	13:00-14:00	0	0	520(1)	64	500(0)	200	52.3	42.4
10	06/25/85	14:00-15:00	0	0	591(0)	75	589(0)	246	52.0	42.1
11	06/26/85	11:00-12:00	0	0	624(1)	95	530(1)	93	49.5	41.3
12	06/26/85	13:00-14:00	0	0	555(2)	69	520(3)	192	49.9	41.1
13	06/26/85	14:00-15:00	0	0	600(1)	74	524(2)	207	49.9	41.0
14	06/27/85	11:00-12:00	0	0	584(2)	65	474(1)	199	46.7	39.9
15	06/27/85	13:00-14:00	0	0	320(1)	47	319(1)	111	49.2	40.6
16	06/27/85	14:00-15:00	0	0	320(0)	46	320(0)	112	48.9	40.6

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR ON 2 - CAMERA LOCATION 2

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	07/09/85	13:00-14:00	0	0	573(1)	70	548(3)	193	48.1	43.5
2	07/11/85	11:00-12:00	0	0	563(1)	77	497(0)	162	51.5	44.2
3	07/11/85	13:00-14:40	0	0	588(1)	70	526(0)	166	52.7	40.5
4	09/05/85	11:00-12:00	0	0	485(0)	81	429(0)	216	49.8	43.1
5	09/05/85	13:00-14:00	0	0	619(1)	179	627(0)	247	50.8	41.4
6	09/05/85	14:00-15:00	0	0	450(1)	130	456(1)	180	50.8	41.2
7	09/19/85	11:00-12:00	0	0	465(0)	95	448(1)	211	49.2	42.4
8	09/19/85	13:00-14:00	0	0	511(1)	83	541(3)	192	48.5	42.8

APPENDIX III
TRAFFIC COUNTS AND SPEEDS
HAR ON 2L - CAMERA LOCATION 2

OBS	DATE	TIME	FC	FT	MC	MT	SC	ST	SPC	SPT
1	10/30/85	11:00-12:00	0	0	464(3)	98	388(3)	226	49.2	45.6
2	10/30/85	13:00-14:00	0	0	490(2)	73	444(2)	218	49.9	41.8
3	10/30/85	14:00-15:00	0	0	531(2)	76	469(1)	236	49.9	41.6
4	11/07/85	11:00-12:00	0	0	0(0)	0	868(6)	329	47.6	39.1
5	11/07/85	13:00-14:00	0	0	448(1)	70	504(1)	230	54.8	48.3
6	11/07/85	14:00-15:00	0	0	511(3)	82	534(1)	216	51.2	45.1

FOR OBS 4 THE MC AND MT ENTRIES ARE 0 BECAUSE THE LANE WAS CLOSED FOR CONSTRUCTION WORK UNTIL 12 NOON.

APPENDIX IV

INTERVIEW DATA COLLECTION PROCEDURE

1. At the start of each interview day the project supervisor made a general inspection of the equipment, checked its operation, and checked the antenna output by driving through the HAR zone and listening to the nonsense message which had been recorded at the end of the previous day of data collection. If necessary the message was changed to the standard HAR ON message, or re-recorded if it had been lost. See Appendix V, page 89 for the recording procedure. Any problems which had occurred were corrected by the supervisor prior to the beginning of interviewing. Those which could not be corrected were referred to the contractor with a reminder that the warning signs were not to be uncovered. If the antenna output was satisfactory and there were no apparent problems which would interfere with HAR function for that day, the supervisor notified the contractor what time the warning signs were to be uncovered, and what time they were to be recovered at the end of the interviewing period for the day.

2. Cones and signs were placed as necessary in the interview area and questionnaires distributed to the 2-4 interviewers.

3. The trooper was informed that the crew was ready and could start selecting vehicles at his discretion. The only restrictions were that he was not to select more vehicles than there were interviewers, and that no additional vehicles were to be directed into the area until the last one from the previous group had left the interview zone. This minimized delay to the motorists and maximized safety within the interview area. Insofar as possible selection of vehicles was random.

4. The interview crew notified the videotaping crew by radio that they were about to start, which was the signal to start videotaping as well. They were also informed of any delay or suspension of interviewing. Lunch was from approximately 12 NOON to 1 p.m. for all personnel. All cones and signs were left in place during this period and HAR left on, since it would have been almost impossible to have the contractor assign someone to cover the warning signs and them uncover them one hour later.

5. As selected vehicles approached the interview area the interviewers completed the first seven questions on the interview sheet, which did not require driver participation (See Figure 6, page 21.) The remainder of the questionnaire was completed by actual interview. During HAR OFF, only Q. 18 - 20 were asked, since the others did not apply for this condition. Any driver who did not wish to participate in the interview was allowed to leave immediately.

6. Interviewing was continuous except for lunch or when police assistance was not available. At 3 p.m. the videotaping crew was informed that interviewing had stopped. All cones and signs were removed, videotaping stopped. All cones and signs were removed, videotaping equipment broken down and loaded into vehicles, and the HAR warning signs covered by the contractor's personnel.

APPENDIX V

HAR MESSAGE RECORDING PROCEDURE

STATUS/TIME REMAINING	ON LINE	RECORD	PLAYBACK	START/STOP

*LED indicates the mode that the recorder is operating in.

Procedure:

1. Hold hand set, and push first button (ON LINE) off to take unit off line. LED will be off, indicating off line from transmitter. STATUS window will indicate "SEL" or select.

2. Push the last button (START/STOP) once, unit will go through self check, showing storage time, etc. in the STATUS window, and will finally indicate "SEL" and remain at that display.

3. Push the second button (RECORD), and STATUS window will indicate the maximum time in seconds or "32".

4. Push START/STOP switch, the STATUS window will indicate the seconds counting down as verbal message is being recorded in the hand set.

5. Push START/STOP switch when message has been completed. STATUS window will indicate "SEL".

6. To PREVIEW recorded messae, push third button (PLAYBACK), at this point the STATUS window will indicate the tie or length of the message.

7. Hold hand set to ear, and press the START/STOP button, to listen and to monitor recorded message. If message is OK, press START/STOP button to stop message.

8. To place unit in transmit mode, push ON LINE button, and recorded mesage will go on the cable.

9. To re-record message, follow steps 3 to 7 above, before placing unit ON LINE.

10. Close and lock transmitter housing cover.

APPENDIX VI

FIELD STRENGTH READINGS

Position	Date							
West	5/15/85	5/28/85	7/18/85	8/22/85	10/8/85	1/24/86	3/26/86	6/10/86
1	.11	---	.071	1.1	46.0	.045	.037	.13
2	1.0	1.0	.78	1.5	.14	.18	.18	.14
3	.52	5.0	.19	1.8	.18	.2	.21	.12
4	1.9	1.9	.52	2.0	.14	.075	.09	.09
5	---	---	1.8	10.0	.27	1.3	.85	.017
6	---	---	1.0	8.0	.84	1.2	.75	.90
7	.56	---	.22	52.0	.75	.5	1.1	.90
8	---	---	3300.0	1200.0	1800.0	9.0	45.0	45.0
9	---	---	4000.0	1500.0	1500.0	85.0	70.0	108.0
East	5/15/85	5/28/85	7/18/85	8/22/85	10/8/85	1/24/86	3/26/86	6/10/86
10	---	---	12.0	1.3	1.5	1.7	1.35	.013
11	---	---	10.5	.95	1.6	1.6	1.4	.011
12	34.0	---	32.0	10.2	1.7	3.1	3.5	.011
13	3100.0	2500.0	2600.0	94.0	1600.0	200.0	2700.0	2.01
14	---	---	74.0	30.3	4.3	13.0	13.0	2.01
15	---	---	4.0	52.0	72.0	50.0	64.0	2.10
16	---	---	110.0	10.0	10.7	24.0	24.0	2.10
17	---	---	55.0	70.0	70.0	84.0	50.0	.013
TRANSMITTER	---	---	6.0	27.0	1.1	50.75	---	---

All readings are in millivolts per meter.
See Figure 7, page 25 for location of positions.

APPENDIX VII

REDUCED INTERVIEW DATA

BY SIGN CONFIGURATION

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 1

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
5/30/85	9	40	11	51	78.4	21.6
6/06/85	9	49	6	55	89.1	10.9
6/13/85	9	37	7	44	84.1	15.9
6/20/85	9	51	8	59	86.4	13.6
6/25/85	9	39	1	40	97.5	2.5
6/26/85	9	73	18	91	80.2	19.8
6/27/85	9	41	3	44	93.2	6.8
5/30/85	8	32	19	51	62.7	37.3
6/06/85	8	28	27	55	50.9	49.1
6/13/85	8	20	24	44	45.5	54.5
6/20/85	8	28	31	59	47.5	52.5
6/25/85	8	17	23	40	42.5	57.5
6/26/85	8	54	37	91	59.3	40.7
6/27/85	8	28	16	44	63.6	36.4
5/30/85	10	4	22	26	15.4	84.6
6/06/85	10	4	21	25	16.0	84.0
6/13/85	10	5	14	19	26.3	73.7
6/20/85	10	4	21	25	16.0	84.0
6/25/85	10	3	14	17	17.6	82.4
6/26/85	10	13	35	48	27.1	72.9
6/27/85	10	7	21	28	25.0	75.0
5/30/85	11	2	2	4	50.0	50.0
6/06/85	11	4	0	4	100.0	0.0
6/13/85	11	2	3	5	40.0	60.0
6/20/85	11	3	1	4	75.0	25.0
6/25/85	11	1	1	2	50.0	50.0
6/26/85	11	8	4	12	66.7	33.3
6/27/85	11	3	4	7	42.9	57.1
5/30/85	12	2	0	2	100.0	0.0
6/06/85	12	4	0	4	100.0	0.0
6/13/85	12	2	0	2	100.0	0.0
6/20/85	12	2	1	3	66.7	33.3
6/25/85	12	1	0	1	100.0	0.0
6/26/85	12	8	1	9	88.9	11.1
6/27/85	12	2	1	3	66.7	33.3

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 1

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
5/30/85	13	2	0	2	100.0	0.0
6/06/85	13	4	0	4	100.0	0.0
6/13/85	13	2	0	2	100.0	0.0
6/20/85	13	2	1	3	66.7	33.3
6/25/85	13	1	0	1	100.0	0.0
6/26/85	13	8	1	9	88.9	11.1
6/27/85	13	2	1	3	66.7	33.3
5/30/85	14	2	0	2	100.0	0.0
6/06/85	14	4	0	4	100.0	0.0
6/13/85	14	2	0	2	100.0	0.0
6/20/85	14	3	0	3	100.0	0.0
6/25/85	14	1	0	1	100.0	0.0
6/26/85	14	8	1	9	88.9	11.1
6/27/85	14	3	0	3	100.0	0.0
5/30/85	4	1	1	2	50.0	50.0
6/06/85	4	0	4	4	0.0	100.0
6/13/85	4	0	2	2	0.0	100.0
6/20/85	4	0	3	3	0.0	100.0
6/25/85	4	1	0	1	100.0	0.0
6/26/85	4	2	6	8	25.0	75.0
6/27/85	4	0	3	3	0.0	100.0
5/30/85	15	2	0	2	100.0	0.0
6/06/85	15	4	0	4	100.0	0.0
6/13/85	15	2	0	2	100.0	0.0
6/20/85	15	2	1	3	66.7	33.3
6/25/85	15	1	0	1	100.0	0.0
6/26/85	15	8	0	8	100.0	0.0
6/27/85	15	2	1	3	66.7	33.3
5/30/85	20	36	15	51	70.9	29.4
6/06/85	20	35	20	55	63.6	36.4
6/13/85	20	34	10	44	77.3	22.7
6/20/85	20	44	15	59	74.6	25.4
6/25/85	20	23	17	40	57.5	42.5
6/26/85	20	63	28	91	69.2	30.8
6/27/85	20	34	10	44	77.3	22.7
5/30/85	21	0	36	36	0.0	100.0
6/06/85	21	0	35	35	0.0	100.0
6/13/85	21	0	34	34	0.0	100.0
6/20/85	21	3	41	44	6.8	93.2
6/25/85	21	0	23	23	0.0	100.0
6/26/85	21	1	63	64	1.6	98.4

6/27/85	21	2	32	34	5.9	94.1

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 1

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
5/30/85	17	3	27	30	10.0	90.0
6/06/85	17	9	25	34	26.5	73.5
6/13/85	17	10	24	34	29.4	70.6
6/20/85	17	9	34	43	20.9	79.1
6/25/85	17	1	22	23	4.3	95.7
6/26/85	17	5	56	61	8.2	91.8
6/27/85	17	9	23	32	28.1	71.9
5/30/85	16	1	1	2	50.0	50.0
6/06/85	16	1	8	9	11.1	88.9
6/13/85	16	5	4	9	55.6	44.4
6/20/85	16	1	6	7	14.3	85.7
6/25/85	16	0	1	1	0.0	100.0
6/26/85	16	4	1	5	80.0	20.0
6/27/85	16	4	4	8	50.0	50.0

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 2

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
7/09/85	9	46	10	56	82.1	17.9
7/11/85	9	56	8	64	87.5	12.5
9/05/85	9	83	6	89	93.3	6.7
9/19/85	9	79	11	90	87.8	12.2
9/26/85	9	52	8	60	86.7	13.3
10/09/85	9	76	12	88	86.4	13.6
7/09/85	8	41	15	56	73.2	26.8
7/11/85	8	45	19	64	70.3	29.7
9/05/85	8	58	31	89	65.2	34.8
9/19/85	8	63	27	90	70.0	30.0
9/26/85	8	37	23	60	61.7	38.3
10/09/85	8	60	28	88	68.2	31.8
7/09/85	10	5	27	32	15.6	84.4
7/11/85	10	11	27	38	28.9	71.1
9/05/85	10	9	44	53	17.0	83.0
9/19/85	10	9	44	53	17.0	83.0
9/26/85	10	6	26	32	18.8	81.3
10/09/85	10	12	39	51	23.5	76.5
7/09/85	11	3	2	5	60.0	40.0
7/11/85	11	3	8	11	27.3	72.7
9/05/85	11	5	4	9	55.6	44.4
9/19/85	11	3	6	9	33.3	66.7
9/26/85	11	3	1	4	75.0	25.0
10/09/85	11	9	3	12	75.0	25.0
7/09/85	12	3	0	3	100.0	0.0
7/11/85	12	2	1	3	66.7	33.3
9/05/85	12	5	0	5	100.0	0.0
9/19/85	12	3	0	3	100.0	0.0
9/26/85	12	2	1	3	66.7	33.3
10/09/85	12	5	4	9	55.6	44.4
7/09/85	13	3	0	3	100.0	0.0
7/11/85	13	3	0	3	100.0	0.0
9/05/85	13	5	0	5	100.0	0.0
9/19/85	13	2	1	3	66.7	33.3
9/26/85	13	3	0	3	100.0	0.0
10/09/85	13	9	0	9	100.0	0.0

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 2

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
7/09/85	14	3	0	3	100.0	0.0
7/11/85	14	3	0	3	100.0	0.0
9/05/85	14	5	0	5	100.0	0.0
9/19/85	14	2	1	3	66.7	33.3
9/26/85	14	3	0	3	100.0	0.0
10/09/85	14	9	0	9	100.0	0.0
7/09/85	4	0	3	3	0.0	100.0
7/11/85	4	1	2	3	33.3	66.7
9/05/85	4	1	4	5	20.0	80.0
9/19/85	4	2	0	2	100.0	0.0
9/26/85	4	2	1	3	66.7	33.3
10/09/85	4	0	9	9	0.0	100.0
7/09/85	15	3	0	3	100.0	0.0
7/11/85	15	0	2	2	0.0	100.0
9/05/85	15	5	0	5	100.0	0.0
9/19/85	15	2	0	2	100.0	0.0
9/26/85	15	3	0	3	100.0	0.0
10/09/85	15	9	0	9	100.0	0.0
7/09/85	20	28	28	56	50.0	50.0
7/11/85	20	44	20	64	68.8	31.3
9/05/85	20	57	32	89	64.0	36.0
9/19/85	20	58	32	90	64.4	35.6
9/26/85	20	35	26	61	57.4	42.6
10/09/85	20	58	30	88	65.9	34.1
7/09/85	21	1	28	29	3.4	96.6
7/11/85	21	2	42	44	4.5	95.6
9/05/85	21	1	56	57	1.8	98.2
9/19/85	21	0	58	58	0.0	100.0
9/26/85	21	1	34	35	2.9	97.1
10/09/85	21	0	58	58	0.0	100.0
7/09/85	17	2	23	25	8.0	92.0
7/11/85	17	5	33	38	13.2	86.8
9/05/85	17	4	47	51	7.8	92.2
9/19/85	17	2	51	53	3.8	96.2
9/26/85	17	11	21	32	34.4	65.6
10/09/85	17	12	43	55	21.8	78.2

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 2

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
7/09/85	16	1	1	2	50.0	50.0
7/11/85	16	2	3	5	40.0	60.0
9/05/85	16	0	4	4	0.0	100.0
9/19/85	16	0	2	2	0.0	100.0
9/26/85	16	2	3	5	40.0	60.0
10/09/85	16	1	0	1	100.0	100.0

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 2L

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
10/30/85	9	78	3	81	96.3	3.7
11/07/85	9	127	8	135	94.1	5.9
11/14/85	9	44	3	47	93.6	6.4
10/30/85	8	49	32	81	60.5	39.5
11/07/85	8	112	23	135	83.0	17.0
11/14/85	8	43	4	47	91.5	8.5
10/30/85	10	16	34	50	32.0	68.0
11/07/85	10	42	66	108	38.9	61.1
11/14/85	10	21	19	40	52.5	47.5
10/30/85	11	12	2	14	85.7	14.3
11/07/85	11	32	10	42	76.2	23.8
11/14/85	11	17	4	21	81.0	19.0
10/30/85	12	7	4	11	63.6	36.3
11/07/85	12	30	2	32	93.8	6.3
11/14/85	12	13	4	17	76.5	23.5
10/30/85	13	11	1	12	91.7	8.3
11/07/85	13	28	2	30	93.3	6.7
11/14/85	13	16	1	17	94.1	5.9
10/30/85	14	11	0	11	100.0	0.0
11/07/85	14	27	1	28	96.4	3.6
11/14/85	14	17	0	17	100.0	0.0
10/30/85	4	11	1	12	91.7	8.3
11/07/85	4	5	23	28	17.9	82.1
11/14/85	4	8	8	16	50.0	50.0
10/30/85	15	2	9	11	18.2	81.9
11/07/85	15	24	4	28	85.7	14.3
11/14/85	15	14	3	17	82.4	17.6
10/30/85	20	52	28	80	65.0	35.0
11/07/85	20	88	44	132	66.7	33.3
11/14/85	20	30	17	47	63.8	36.2

APPENDIX VII

REDUCED INTERVIEW DATA BY SIGN CONFIGURATION

HAR ON 2L

DATE	QUESTION	YES	NO	TOTAL	%YES	%NO
10/30/85	21	2	50	52	3.8	96.2
11/07/85	21	5	84	89	5.6	94.4
11/14/85	21	3	27	30	10.0	90.0
10/30/85	17	9	41	50	18.0	82.0
11/07/85	17	22	61	83	26.5	73.5
11/14/85	17	6	24	30	20.0	80.0
10/30/85	16	2	6	8	25.0	75.0
11/07/85	16	8	11	19	42.1	57.9
11/14/85	16	2	3	5	40.0	60.0

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